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1993

POWER TEN INC.

486 Mercury Drive
Sunnyvale, California
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OPERATOR AND MAINTENANCE MANUAL

600 WATT DC POWER SUPPLY

SERIES 3300D

MODEL 2030

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OPERATOR AND MAINTENANCE MANUAL

600/1000 WATT DC POWER SUPPLY

SERIES 3300

POWER TEN INC.
486 Mercury Drive
Sunnyvale, California 94086

WARNING

Hazardous voltages (greater than 50 volts) may be present when cover is removed and could cause injury to personnel. Wear safety glasses with cover removed. Authorized personnel only should remove cover.

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CHAPTER 1

DESCRIPTION OF EQUIPMENT

1-1. PURPOSE AND CAPABILITIES

The Power Ten Inc. Series 3300 power supply is general purpose power supply designed specifically for laboratory test and systems applications requiring variable DC sources with good regulation and low output ripple characteristics. The Series 3300 power supply is constant current/constant voltage power supplies with an automatic crossover feature. It provides up to 1000 watts of DC power over a wide range of voltage and current levels.

1-2. TECHNICAL CHARACTERISTICS

The physical, electrical and environmental characteristics for Series 3300 are listed in Tables 1-1 and 1-2.

Table 1-1. Series 3300 Technical Characteristics

PARAMETERS	SPECIFICATIONS
PHYSICAL CHARACTERISTICS:	
Width	19 in.
Depth	18.5 in.
Height	1.75 in.
Weight	15 lbs.
ELECTRICAL CHARACTERISTICS:	
Input Power (standard)	
Voltage	95-127 VAC (Standard) 190-253 (Option)
Frequency	47 to 63 Hz
Phase	Single, 2 wire plus GND
Regulation (Line or Load)	
Voltage	0.1% of max output voltage
Current	0.1% of max. output current
Noise and Ripple (RMS)	30 mV max.
Transient Response	A 30% step load will recover to within 2% of final value within 10 ms.
Stability	±0.05% of set point for 8 hours after warm-up and at a fixed line, load and temperature.
Remote Control	On/Off control via contact closure, 6-120 VDC or 12-240 VAC.

Table 1-1. Series 3300 Technical Characteristics - Continued

PARAMETERS	SPECIFICATIONS
ELECTRICAL CHARACTERISTICS:	
Remote Programming	
Resistive:	
Constant Voltage(0-100%)	0 - 5K ohms
Constant Current(0-100%)	0 - 100 ohms
Voltage:	
Constant Voltage(0-100%)	0 - 5 VDC
Constant Current(0-100%)	0 - 100 mV
Current:	
Constant Voltage(0-100%)	0 - 1 mA
Constant Current(0-100%)	0 - 1 mA
Remote Sensing	Terminals are provided to sense output voltage at point of load (except models with greater than 60 VDC output).
ENVIRONMENTAL CHARACTERISTICS:	
Temperature Coefficient	0.02%/deg. C of max. output voltage rating for voltage set point. 0.03%/deg. C of max. output current rating for current set point.
Ambient Temperature	
Operating	0 to 50 degrees C
Storage	-40 to 75 degrees C
Cooling	Forced Air Cooled

Table 1-2. 3300 Technical Characteristics

MODEL NO.	OUTPUT DC		OUTPUT RIPPLE (RMS)
	VOLTS	AMPS	
7.575	0-7.5	0-75	30 mV
1060	0-10	0-60	30 mV
2030	0-20	0-30	30 mV
4015	0-40	0-15	30 mV
6010	0-60	0-10	30 mV
7.5125	0-7.5	0-125	30 mV
10100	0-10	0-100	30 mV
2050	0-20	0-50	30 mV
4025	0-40	0-25	30 mV
6016	0-60	0-16	30 mV
8006	0-80	0-6	60 mV
8012	0-80	0-12	60 mV

CHAPTER 2

INSTALLATION

2-1. INSPECTION

Inspect the shipping carton for possible damage before unpacking the unit. Carefully unpack the equipment. Save all packing materials until inspection is complete. Verify that all items listed on the packing slips have been received. Visually inspect all exterior surfaces for broken knobs, connectors or meters. Inspect for dented or damaged exterior surfaces. External damage may be an indication of internal damage. If any damage is evident, immediately contact the carrier that delivered the unit and submit a damage report. Failure to do so could invalidate future claims.

2-2. INPUT/OUTPUT CONNECTORS

Table 2-1 lists all external connectors for Series 3300.

2-3. LOCATION AND MOUNTING

The Series 3300 is intended for mounting in a standard 19-inch equipment rack. Four captive screws, two on each side of the front panel, are used to secure the unit in place. The unit is also suitable for workbench applications.

2-4. CHECKOUT AND PRELIMINARY ADJUSTMENTS

Follow the instructions in paragraph 3-2 for setup and operation of the equipment.

Table 2-1. Series 3300 Input/Output Connectors

CONNECTOR	FUNCTION	CONNECTS TO
TB2 - AC TB2 - AC CHASSIS - GND	Prime Power Input (STD)*	95-127 VAC 47-63 Hz Power Source
Pos. Bus Bar Neg. Bus Bar GND Stud	Output Power	User Load(s)
TB1	Control Interface	See Table 3-2 For Description

*190-253 VAC is available as a factory option.

CHAPTER 3

OPERATING INSTRUCTIONS

3-1. CONTROLS AND INDICATORS

Front panel controls and indicators for the Series 3300 are identified in Figure 3-1 with index numbers keyed to Table 3-1. Table 3-1 provides a description of all operator controls and indicators.

3-2. SETUP AND OPERATING INSTRUCTIONS

The following paragraphs provide setup and operating procedures for the Series 3300.

The power supply may be configured via TB1 for different operating configurations: local and remote current programming, local and remote voltage programming, normal parallel, auto-parallel, normal series, auto-series, and auto-tracking. The use and operating requirements of each configuration are provided in the following paragraphs. Reference Table 3-2 for barrier strip TB1 designations and functions.

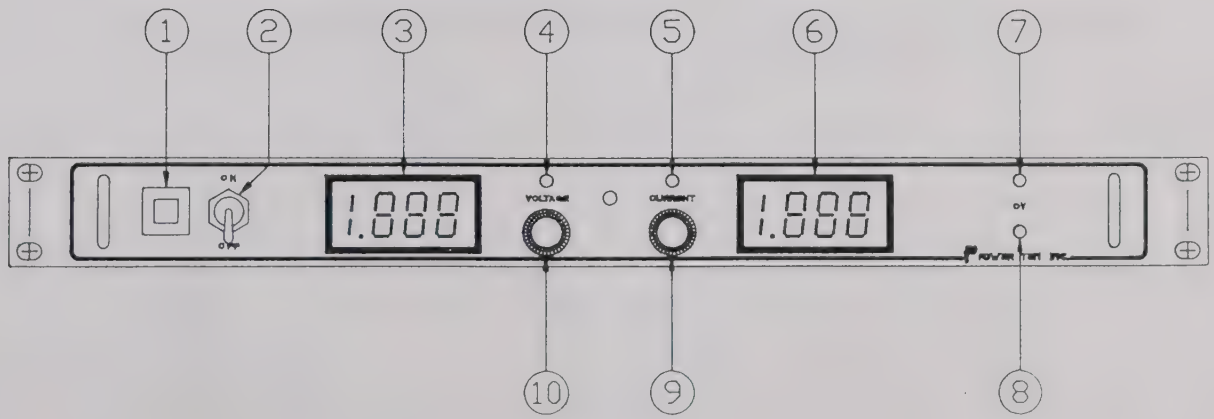


Figure 3-1. Series 3300 Control and Indicators

Table 3-1. Series 3300 Controls and Indicators

FIGURE & INDEX NO	CONTROL/INDICATOR	FUNCTION
3-1		
-1	Circuit Breaker	Provides fault protection
-2	POWER Switch	Applies AC power to the power supply.
-3	VOLTAGE Meter	Measures voltage output.
-4	Voltage Mode Indicator	Indicates the power supply is operating in the voltage mode.
-5	Current Mode Indicator	Indicates the power supply is operating in the voltage mode.
-6	CURRENT Meter	Measures current output.
-7	OVERVOLTAGE Indicator	Indicates output voltage has exceeded preset level, and power supply output is turned off.
-8	Overvoltage Potentiometer	Adjusts overvoltage trip level.
-9	Output Current Control	Adjusts current control to desired level.
-10	Output Voltage Control	Adjusts voltage control to desired level.

Table 3-2. Barrier Strip (TB1) Designations and Functions

TB1 DESIGNATOR	SCHEMATIC SYMBOL	FUNCTIONAL DESCRIPTION
1	V+	Positive output voltage for local voltage sensing.
2	VS+	*Positive voltage sensing terminal.
3	VPROG	1 milliamp current source for either local or remote voltage programming using resistance.
4	VCONT	Voltage control input terminal.
5	VSET	Front panel voltage control potentiometers for local control.
6	VS-	*Negative voltage sensing terminal.
7	V-	Negative output voltage for local voltage sensing.
8	IPROG	1 milliamp current source for either local or remote current programming using resistance.
9	ICONT	Current control input terminal.
10	ISET	Front panel current control potentiometers for local control.
11	IMON-	Negative current monitor terminal. Return for remote current programming resistor.
12	IMON+	0-5 VDC = 0-100% rated current. User positive current monitor terminal or 0-1 milliamp auto-tracking control output terminal. Referenced to TB1-13.
13	ON/OFF CONTACT RTN	Control Circuit Common. Used with TB1-12 for current monitor and/or TB1-14 for remote on/off ctrl rtn.
14	ON/OFF CNTCT CTRL	Remote on/off control using contacts of switch or relay

*Except in models in excess of 60 VDC output.

Table 3-2. Barrier Strip (TB1) Designator and Functions - Continued

TB1 DESIGNATOR	SCHEMATIC SYMBOL	FUNCTIONAL DESCRIPTION
15	ON/OFF AC/DC RTN	Return for AC/DC voltage source used for remote on/off control.
16	ON/OFF AC/DC	Externally supplied AC/DC voltage source for on/off output voltage control. This is a positive (+) terminal for DC voltage.

a. Local Operation. Units are shipped from the factory configured for local voltage/current control and local voltage sensing. This configuration is used for applications where the IR drop of the load wires is insufficient to degrade performance at the load. The strapping pattern is provided in Figure 3-2. Prior to turning the unit on, rotate the voltage and current potentiometers fully counterclockwise (minimum output). Then switch the power to the ON position and adjust the voltage and current to the desired output.

b. Remote Current Programming. The remote current programming configuration is used for applications that require the output current be programmed (controlled) from a remote source. An external resistance or external floating voltage source may be used for a programming device. When using remote current programming, a shielded, twisted pair hookup wire is recommended to prevent noise interference with programming signals.

(1) External Current Programming Using Resistance. The resistance coefficient for remote current programming is 100 ohms per 100% rated output. The programming current from the current control programming terminal A3 is factory set for 1 milliampere. This yields a coefficient of 1% of rated output current per ohm (1%/ohm). If multiple switches or relays are used to program different levels, make-before-break contacts are recommended. See Figure 3-3A for strapping requirements.

(2) External Current Programming Using a Voltage Source. The voltage coefficient for remote current programming is 1 millivolt per percent of rated output current or 100 millivolts equals 100 percent of rated output. On models with 10 V programming, the programming coefficient is 0.1 volt per percent of rated output or 10 volts = 100%. See Figure 3-3B for strapping requirements.

c. Remote Voltage Programming. The remote voltage programming configuration is used for applications that require the output voltage be programmed (controlled) from a remote source. An external resistance or external floating voltage source may be used as a programming device. When using remote voltage programming, a shielded twisted pair hookup wire is recommended to prevent noise interference with programming signals.

(1) External Voltage Programming Using Resistance. The resistance coefficient for remote voltage programming is 5k ohms = 100% of rated output voltage. The programming current from terminal 3 is factory set to 1.000 mA. If multiple switches or relays are used to program different levels, make-before-break contacts are recommended. See Figure 3-4 for strapping requirements.

(5) External Voltage Programming. The voltage coefficient for external voltage programming is 5 volts = 100% of rated output voltage. On models with 10 V programming, the programming

coefficient is 0.1 volt per percent of rated output or 10 volts = 100%. To program voltage slightly above the rated output will not damage the unit, but degraded performance may result. See Figure 3-5 for strapping requirements.

d. Remote Sensing. In applications where the load is located some distance from the power supply or the voltage drop of the power output leads significantly interferes with load regulation, remote voltage sensing may be used. When remote sensing is used, voltage is regulated at the load versus the power supply output terminals. To connect the power supply for remote voltage sensing, see Figure 3-6.

CAUTION

If power supply is operated with load power lines disconnected and sensing line connected, internal power supply damage may occur. (Output current then flows through sensing terminals.)

(1) Remove jumper between the positive sense terminal (TB1-2) and the positive output monitor terminal (TB1-1).

(2) Remove jumper between the negative sense terminal (TB1-6) and the negative output monitor terminal TB1-7.

(3) Connect sensing leads from the load positive to TB1-2 and the load negative to TB1-6. A shielded, twisted pair is recommended to avoid potential noise interference.

e. Remote Output On/Off Control. Remote on/off control may be accomplished by contact closure or by an external AC/DC voltage source.

(1) Remote on/off by contact closure. See Figure 3-7A for strapping requirements. Output is on when contacts are closed.

(2) Remote on/off control may be accomplished by an external AC voltage of 12 to 240 VAC or an external DC voltage of 6 to 120 VDC. See Figure 3-7B for strapping requirements. Application of AC or DC voltage will turn on the power supply.

NOTE

The following modes of operation are used for applications requiring greater output current of voltage than is available from a single power supply. For greater output, two or more supplies may be connected in parallel.

f. Auto-Parallel Operation. In the auto-parallel mode of operation, a master/slave configuration is established.

CAUTION

When using two or more supplies in parallel, damage may occur to slave(s) crowbar circuits if slave overvoltage level set is not higher than the master overvoltage level set. To prevent damage, set all slave units overvoltage-set potentiometers fully clockwise and the master unit to the desired trip level. If over-voltage protection is not desired, set to trip at maximum rated voltage (less than fully clockwise).

To set up the auto-parallel mode of operation, connect all outputs in parallel to load. Connect jumper from master TB1-12 to slave TB1-9 and TB1-10. Remove jumper between slave TB1-8 and TB1-9. Rotate slave voltage control potentiometers to maximum and adjust current control potentiometers for balanced output currents during operation. Once adjusted, output currents will track automatically. If tracking is not close, perform the calibration procedures listed in Chapter 5. See Figure 3-8 for strapping requirements.

g. Auto-Series Operation. In the auto-series mode of operation, a master/slave configuration is established. With two or more supplies connected in series, one is established a master and the remaining units as slaves. The master supply must always be the most positive unit. When operating in the auto-series mode, voltage control potentiometer settings determine the percentage of total load voltage contribution by slaves units. Current control potentiometers of the slave units are active and should be set to maximum clockwise position. See Figure 3-9 for the strapping requirements.

h. Auto-Tracking Operation. In the auto-tracking mode of operation of master/slave configuration is established. In this configuration, two or more supplies may be connected with common negative outputs.

The slave(s) output voltage is a percentage of the master as controlled by the slave(s) voltage control potentiometers. Individual current controls on both master and slave(s) remain active. See Figure 3-10 for strapping requirements.

i. Output Overvoltage Protection. If the power supply is equipped with an overvoltage crowbar, the front panel will contain overvoltage adjustment. This potentiometer may be adjusted through an access hole in the front panel.

NOTE

All overvoltage circuitry has been properly adjusted to their respective unit before leaving the factory.

For trip levels less than the maximum output voltage or to check the overvoltage circuitry, perform the following procedure.

(1) Set the potentiometer fully clockwise.

(2) Adjust the power supply output voltage to the desired trip level.

(3) Slowly adjust the potentiometer counterclockwise until overvoltage is tripped.

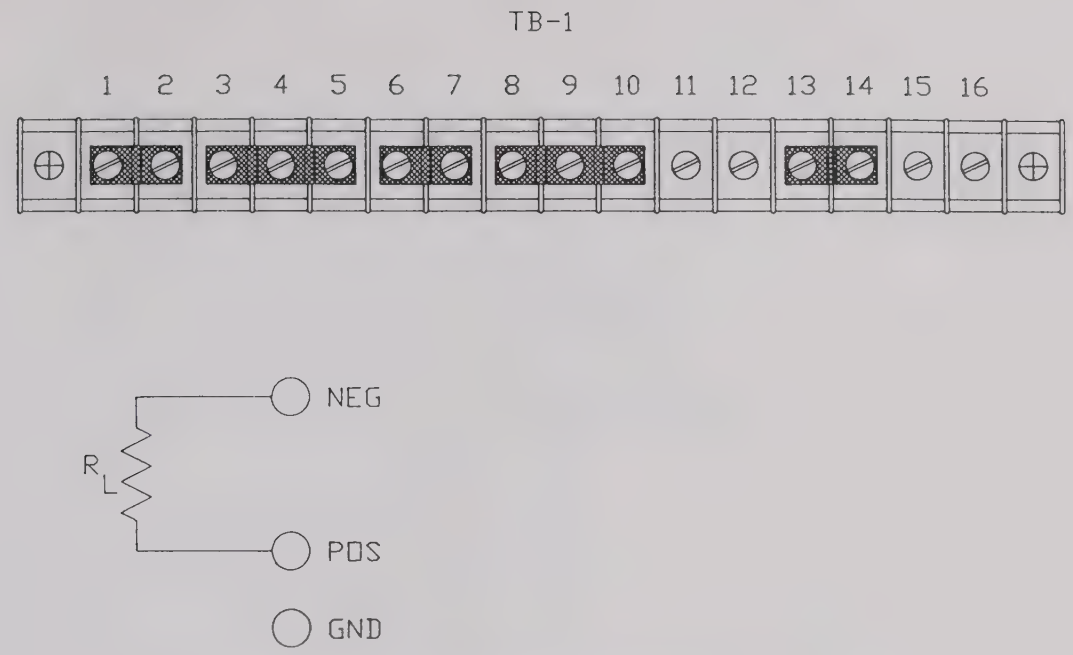
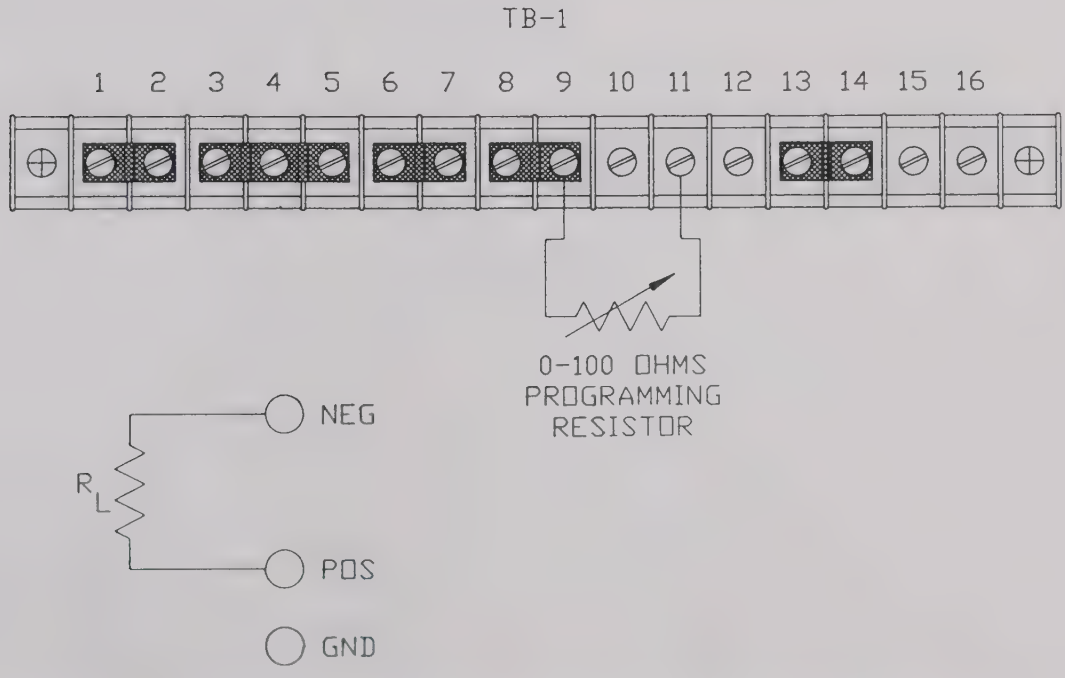


FIGURE 3-2. NORMAL STRAPPING PATTERN



FUGURE 3-3A. REMOTE RESISTANCE PROGRAMING OF OUTPUT CURRENT

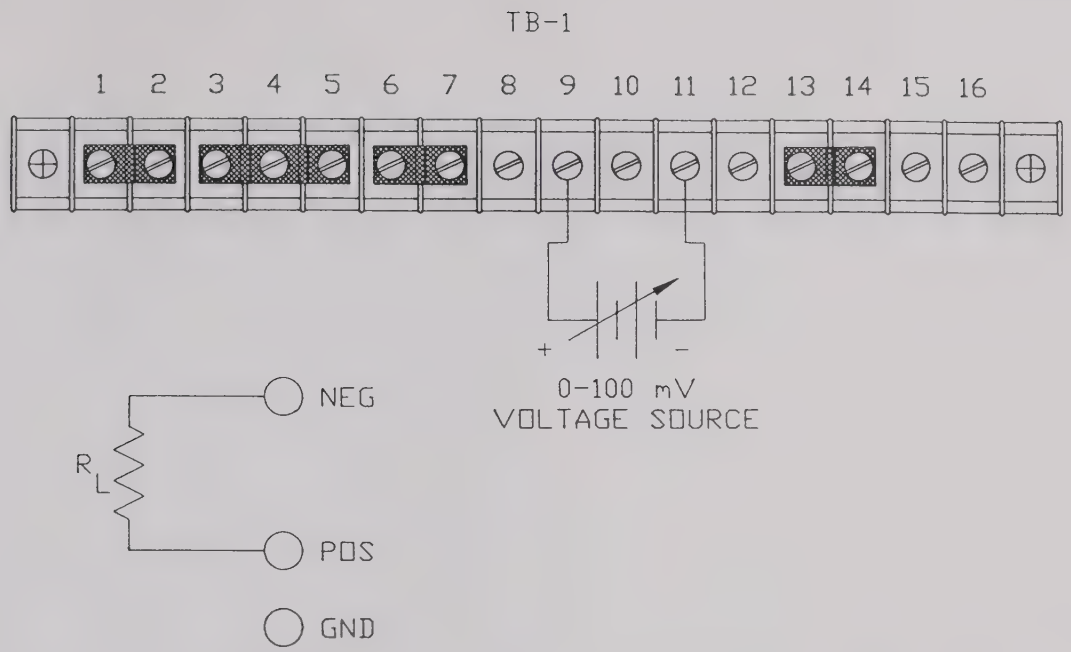
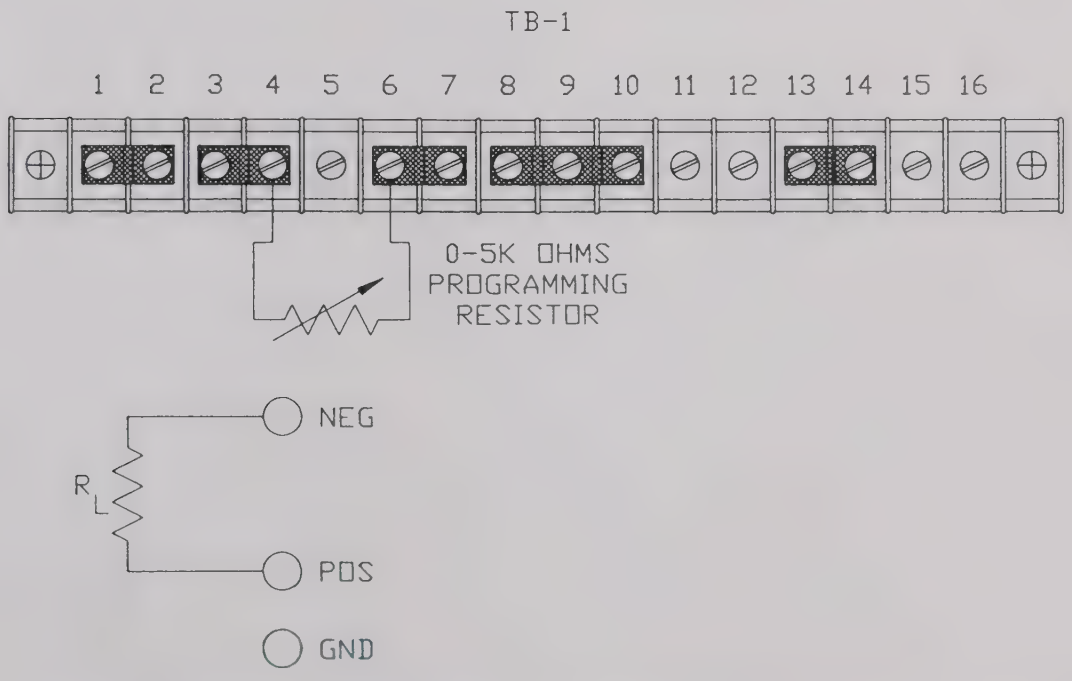


FIGURE 3-3B. REMOTE VOLTAGE PROGRAMMING OF OUTPUT CURRENT



FUGRE 3-4. REMOTE RESISTANCE PROGRAMMING OF OUTPUT VOLTAGE

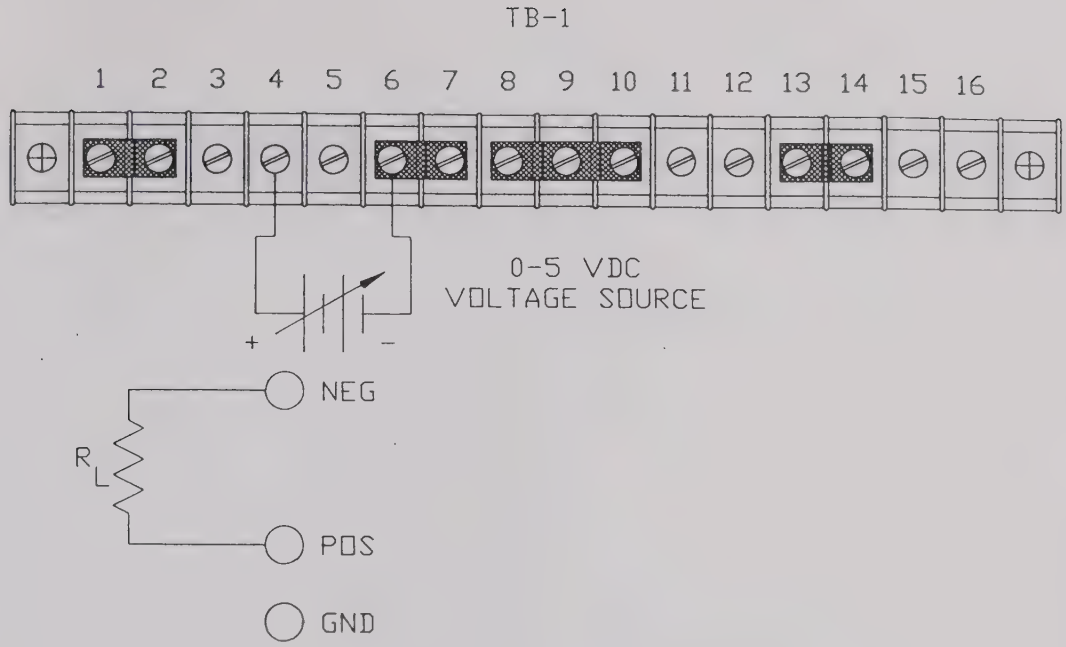
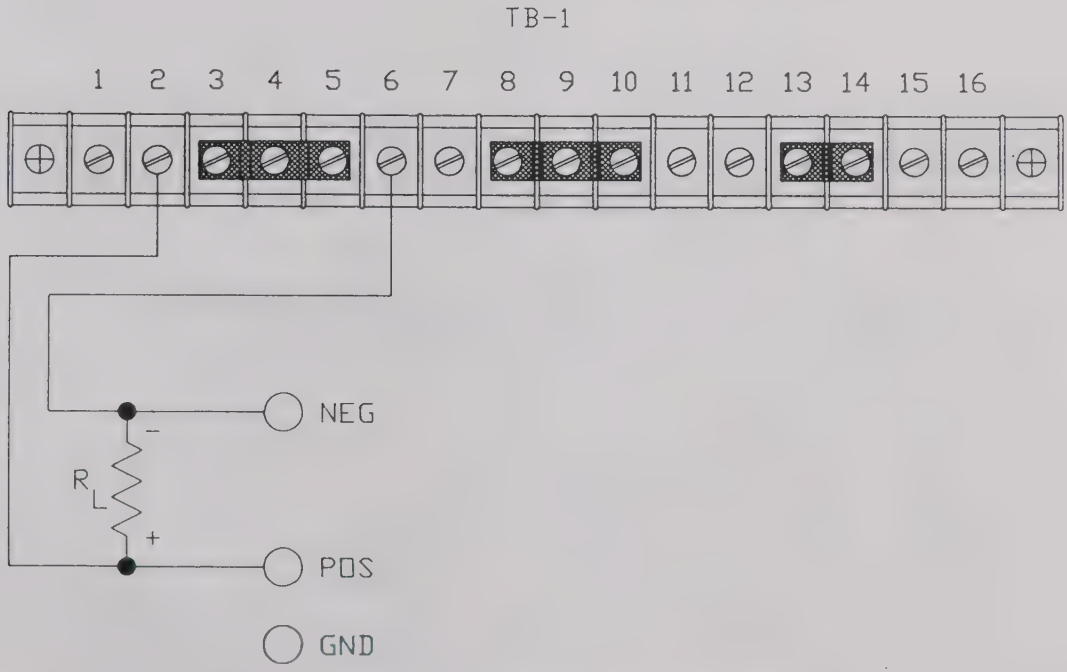


FIGURE 3-5. REMOTE VOLTAGE PROGRAMMING OF OUTPUT VOLTAGE



3-6. REMOTE SENSING OPERATION

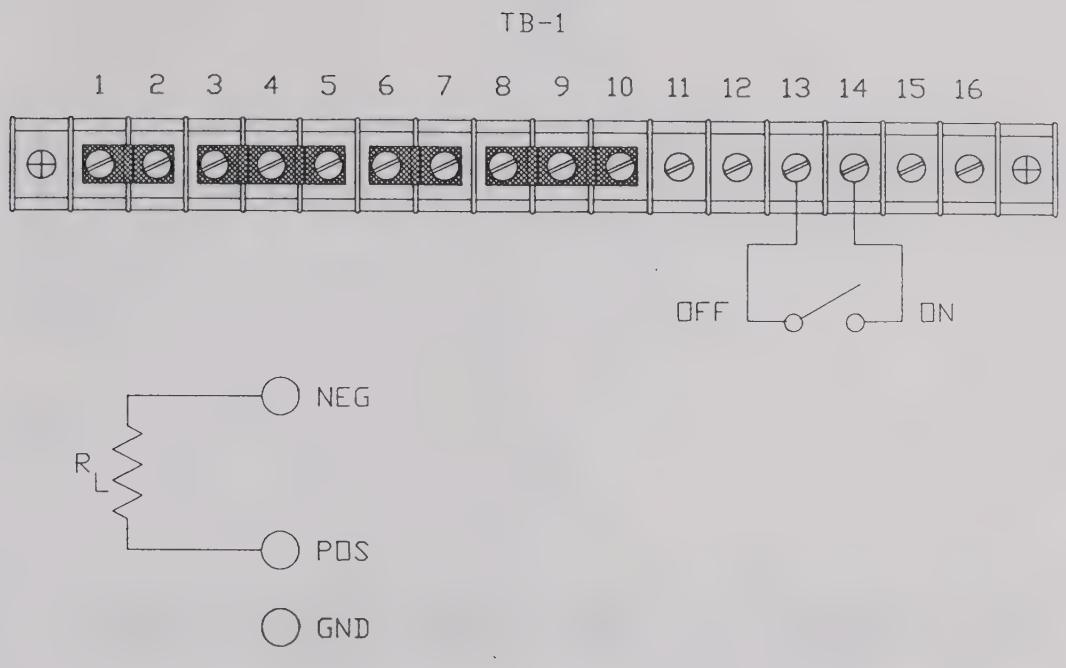


FIGURE 3-7A. REMOTE ON/OFF CONTROL BY CONTACT CLOSURE

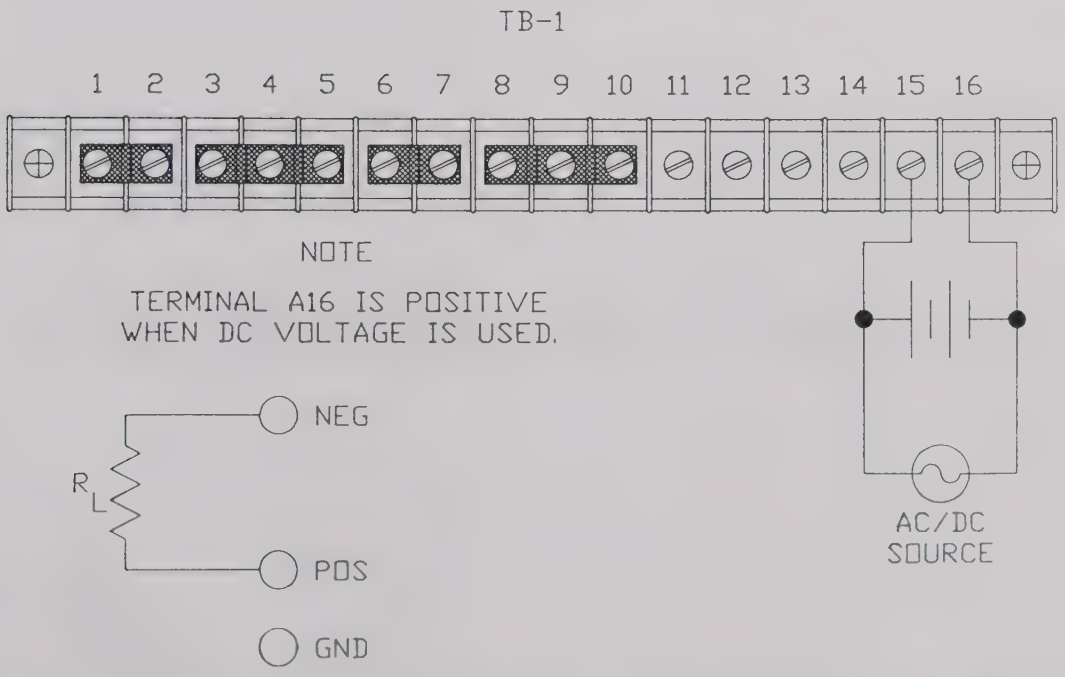


FIGURE 3-7B. REMOTE ON/OFF OPERATION USING AC/DC VOLTAGE SOURCE

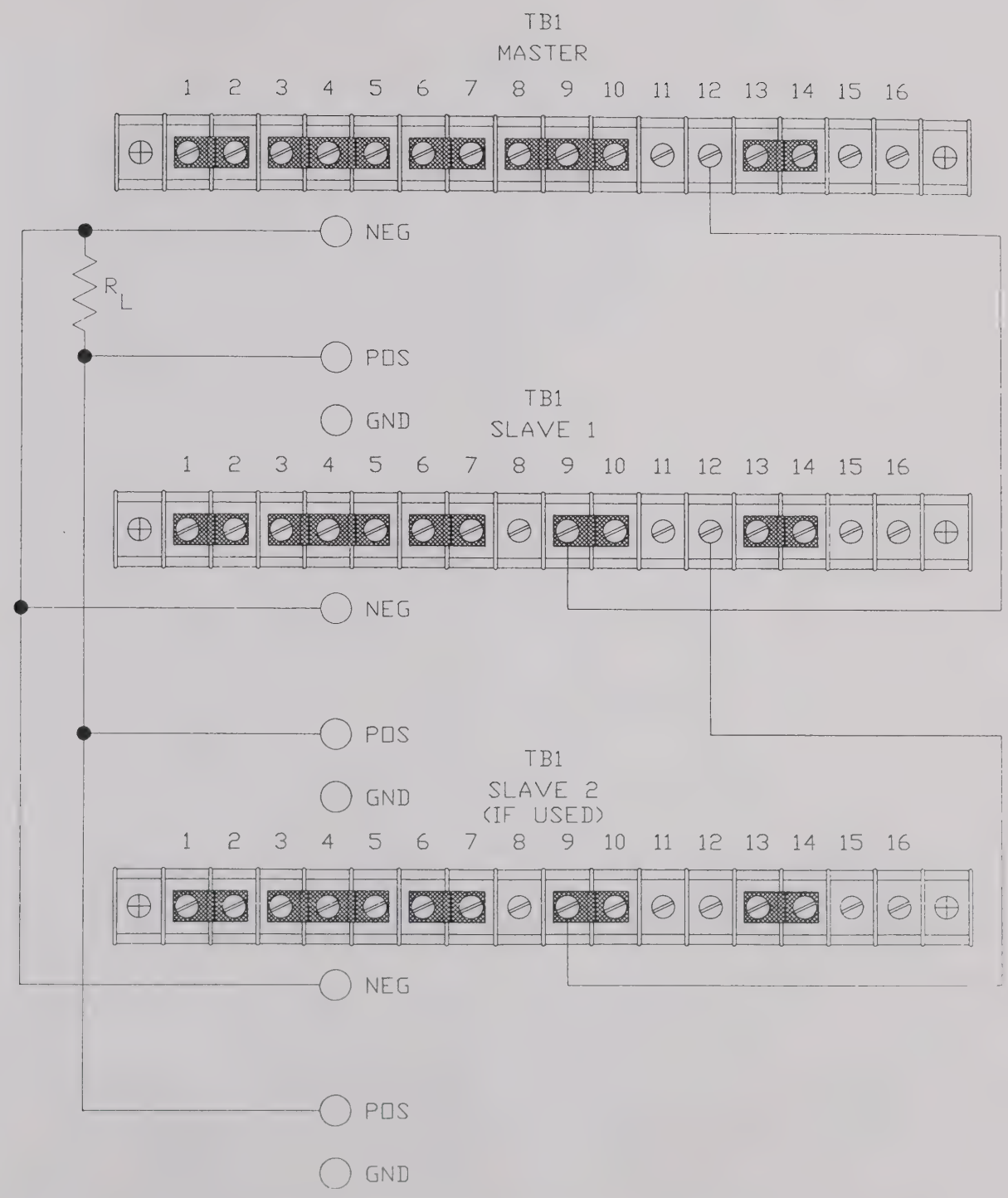
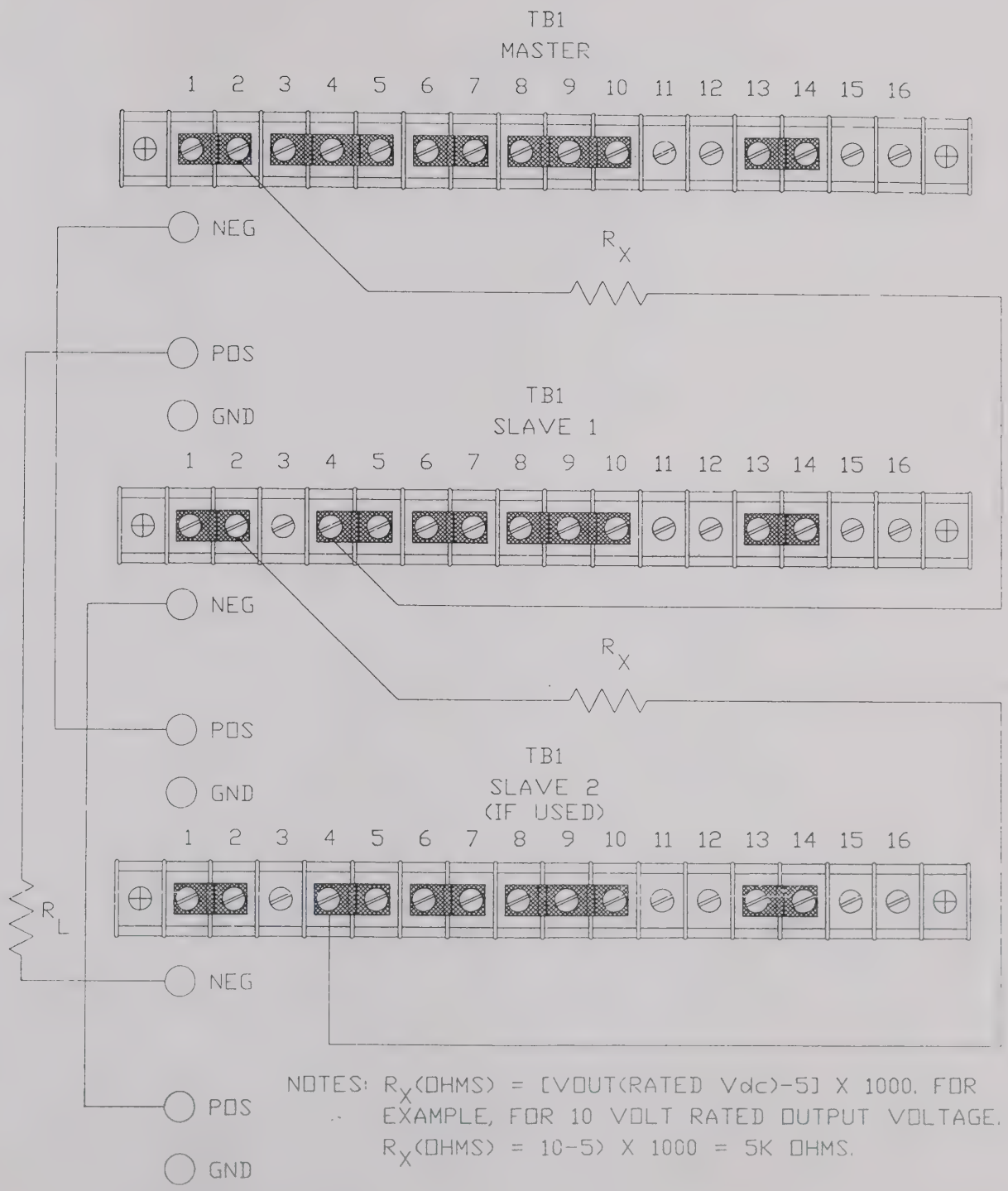
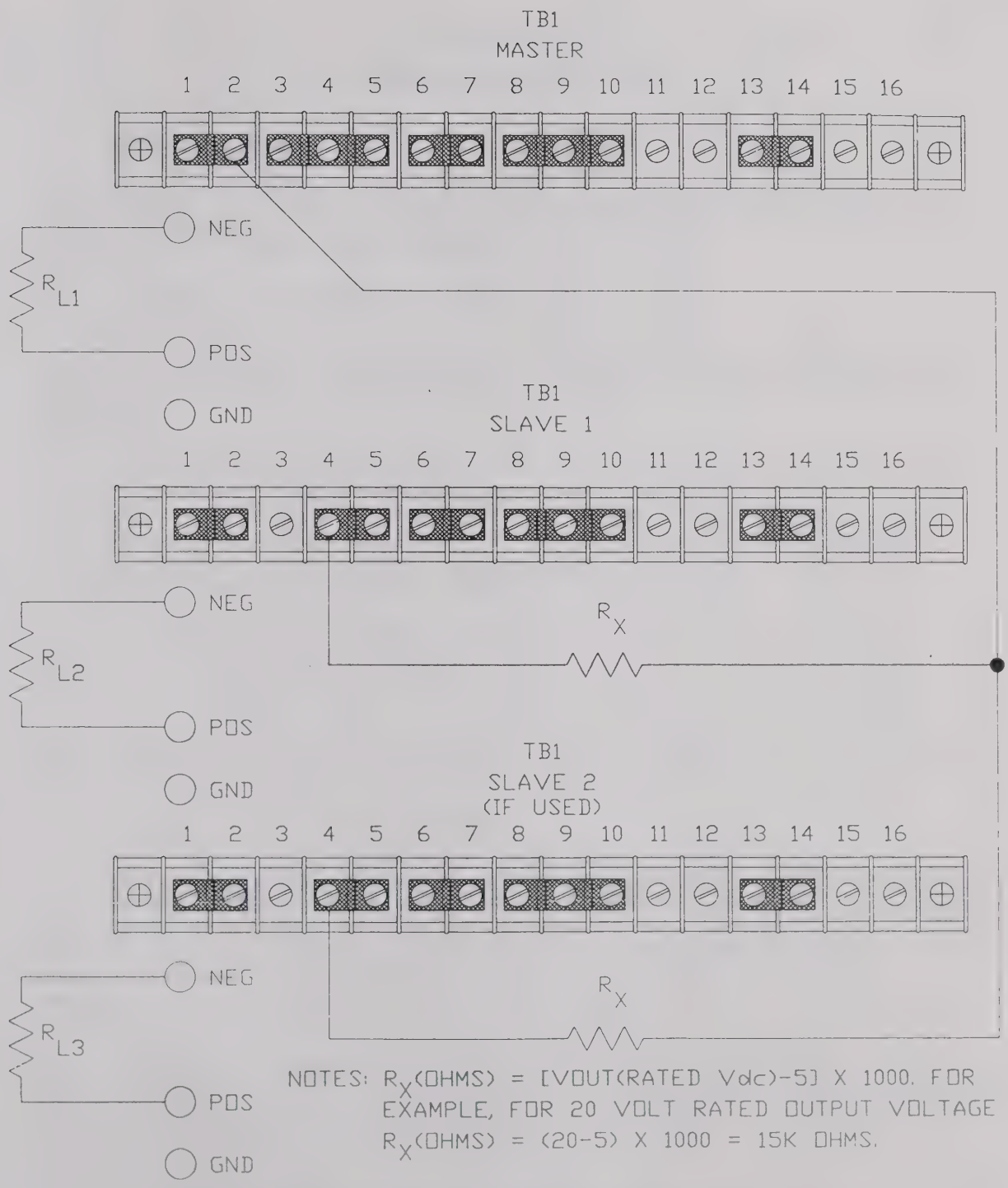


FIGURE 3-8. AUTO-PARALLEL OPERATION



NOTES: R_X(OHMS) = [VOUT(RATED Vdc)-5] X 1000. FOR EXAMPLE, FOR 10 VOLT RATED OUTPUT VOLTAGE. R_X(OHMS) = 10-5) X 1000 = 5K OHMS.

FIGURE 3-9. AUTO-SERIES OPERATION



NOTES: R_X(OHMS) = [VOUT(RATED Vdc)-5] X 1000. FOR EXAMPLE, FOR 20 VOLT RATED OUTPUT VOLTAGE R_X(OHMS) = (20-5) X 1000 = 15K OHMS.

FIGURE 3-10. AUTO-TRACKING OPERATION

CHAPTER 4

PRINCIPLES OF OPERATION

4-1. INTRODUCTION

This chapter provides a description of the Series 3300 power supply. Reference schematics, located in Chapter 7, 3300-90, 10-010-085-90 (A1) and 10-010-086-90 (A2).

4-2. GENERAL DESCRIPTION

The Series 3300 power supply is an on-line switching supply operating at approximately 60 kHz. Regulation is attained by a pulse-width modulator. There are two major subassemblies in each power supply.

a. Converter Assembly (A1). The converter assembly is a full-bridge converter that converts the input unregulated DC voltage to a pulse-width modulator 60 kHz AC to drive the power transformer T4. Also included on the assembly is the central control for the power supply including local/remote controls, indicators, monitors, meters sensing and protection circuits.

b. Display Assembly (A2). This assembly primarily contains the front panel digital meters, indicators, and overvoltage adjustment potentiometer.

c. Top Assembly. The top assembly includes the input power distribution section, the EMI filter, the blower as well as the PWB assemblies mentioned above (A1,A2).

4-3. DETAILED CIRCUIT DESCRIPTION

a. Top Assembly (reference schematic 3300-90). This section discusses the input power distribution which includes the input EMI filter, circuit breaker, power switch and blower that provides cooling for the power supply. Power input from the rear panel is routed through the EMI filter FL1, power switch S1, series circuit breaker CB1 to the blower B1 and to the converter assembly A1.

b. Converter Assembly A1 (reference schematic 10-010-085-90). The primary purpose of the converter assembly is to convert the input DC unregulated line to a regulated DC output including all control and protection circuits.

The converter assembly contains the ±12 V bias regulators, the bias enable circuit, the thermal detector circuit, the slow-start for the pulse-width modulator, the pulse-width modulator, the

basedrive amplifiers, basedrive circuits and power switches U10, U11, U12 and U13.

(1) ±12 V Bias Regulators. The AC input bias is routed from T3 to BR2. The output of BR2 is a nominal ±17 V and is filtered by C20 and C21, respectively, then routed to U1 and U2. U1 provides a +12 V regulated output bias to drive all internal power supply housekeeping functions. U2 provides -12 V internal bias for the same purpose.

(2) Bias Enable Circuit. The bias enable circuit prevents power supply operation should bias voltages become marginal. This would occur during a brown out condition or because of a malfunction of the bias supply.

The U9A and the voltage divider R36 and R37 comprise a voltage error amplifier circuit which uses the pulse-width modulators 5-volt reference to the non-inverting input pin 3. When the unregulated bias voltage at BR2 positive output is below 15 V, the output of U9A, pin 1, is high which turns on Q14, thereby inhibiting the pulse-width modulator from switching. The output of the bias enable circuit U9A is ORed with the thermal detector circuit U9B, overvoltage protection circuit U9D, current limited U5 and on/off control U6.

(3) Thermal Detector Circuit. The purpose of the thermal detector circuit is to provide protection for the bridge converter in the case that the cooling is inadequate or the power supply is subjected to temperatures above the normal specified operating range.

The thermal detector circuit consists of U9B, U3 (thermal sensor) and associated components. The reference input for U9B, pin 6, is provided by the 5-volt reference from U4 through R42, R105 voltage divider. The input temperature is sensed by U3 which provides a linear ramp of 10 mV per degree C at the input (pin 5). When the temperature of the power supply exceeds a safe operating level, pin 5 exceeds the reference of pin 6, thereby activating U9B and shutting down the pulse-width modulator via Q14 and the slow-start circuit.

(4) Overvoltage Detector/Crowbar Circuit. The overvoltage detector/crowbar circuit consists of U9C, U9D, SCR1 and associated components.

The reference input to the overvoltage detector is derived from the reference supply of U4 (+5 VDC) through the overvoltage adjustment potentiometer on the display assembly A2. This input is routed to U9C, pin 9. The output voltage is sensed through voltage divider R53 and R54, and then applied to U9C, pin 10. If the output voltage exceeds a preset level, U9C output, pin 8, goes high and provides a self-latch via CR8. The output also provides drive to U9D and the overvoltage indicator through R55. U9D provides noise immunity for the crowbar SCR1 because of the

5-volt reference voltage on the inverting input U9D, pin 13. The output of U9C, pin 8, must exceed approximately 6 volts DC prior to activating the crowbar SCR1 through R59 or shutting down the pulse-width modulator through R58 and Q14.

(5) Remote On/Off Output Control. Remote on/off control may be accomplished by two methods.

(a) Switch or contact closure. A switch, set of relay contacts, or a semiconductor switch, may be used to provide contact between TB1-13(-) and TB1-14(+). When using a semiconductor switch, it must be capable of sinking approximately 1 milliampere of current from TB1-14(+) to TB1-13(-) return.

(b) AC/DC Voltage Source. An isolated (floating) input at TB1-15 and TB1-16 is available for either 12 to 240 VAC or 6 to 120 VDC source on/off control. When DC voltage is used for control, the (+) positive input is at TB1-16 with reference to TB1-15 return.

Both methods of using remote on/off output control require that the jumper between TB1-13 and TB1-14 be removed.

An AC or (+)DC voltage input to TB1-16 provides current flow through CR9, R65, R64 and Q17 opto-coupler back to TB1-15 return. Q17 transistor output is activated, thereby pulling U6C, pin 10, below the 5 volt reference at U6C-9. The output of U6C, pin 8, is switched low permitting Q14 to turn off and the pulse-width modulator U4 to operate.

When a switch, contact closure or semiconductor, is used between TB1-14(+) and TB1-13(-), the input is in parallel with Q17 and operates in a similar manner as described above.

(6) Current Limit. The current limit circuit consists of U5 and associated components. When a preset current level is sensed across R18, it is routed through R33 and R35 to the inverting input of U5, pin 2. The sensed level is negative, so the output of U5, pin 6, is positive, forward biasing CR7 through R31 and providing basedrive to Q14 and momentarily shutting down the pulse-width modulator.

This circuit only activates during instantaneous short circuit conditions. During the normal overcurrent condition, the current control circuit U7 provides protection.

(7) Pulse-Width Modulator. The pulse-width modulator U4 is the central control for pulse-width modulation within the power supply. It is controlled by all of the logic functions as well as the regulation loops.

The paragraphs above describe the inputs to the pulse-width modulator for shutdown via the slow-start circuit of the bias enable, thermal detector, overvoltage detector, on/off control

and current limit circuits. The other input is in the error amplifier, pins 1 and 2, which provides linear voltage or current regulation inputs. The reference input to U4, pin 2, is provided from the 5-volt reference at pin 16. The error signal input is routed through CR11 (current mode) or CR15 (voltage mode) and through R51 to U4, pin 1. R50 and C36 provide a compensation network for stability. The output pulse-width modulation information is routed through pins 11 and 14 to the basedrive amplifier.

(8) Basedrive Amplifier. The purpose of the basedrive amplifier is to amplify pulse-width modulation signal from U4 and condition it to drive the basedrive transformers T1 and T2. Both sides of the basedrive amplifier are identical, so only one will be described to provide theory of operation.

The pulse-width modulator output of U4 consists of a totem-pole transistor driver on pins 11 and 14. The output from U4, pin 11, provides emitter drive to Q5 and Q6 through R20. Both Q5 and Q6 bases are connected to the 5-volt reference from U4, pin 16. When U4, pin 11, is high (approximately 11 VDC), Q6 is turned on through R20 providing basedrive to Q8; this results in negative drive to T1 and T2 left end. When U4, pin 11, is low (approximately 1 VDC), Q5 is turned on providing basedrive to Q5; this results in positive drive to T1 and T2 left end. The right side of the basedrive amplifier, Q9, Q10, Q11, and Q12 operate similar to Q5, Q6, Q7 and Q8, but with opposite polarity drive.

(9) Converter Switch Transistors. The Series 3300 power supplies utilize a full-bridge converter consisting of MOSFET transistors Q1-Q4 with associated gate and snubber circuits. Q1 and Q4 alternate "on" cycles with Q2 and Q3. The output from the converter switch transistors is a 60 kHz, pulse-width modulated AC drive to power transformer T4.

(10) Voltage Reference Circuit. The voltage reference circuit is an adjustable current source which is factory set for one milliampere. This reference is routed to TB1-3 (VPROG.) for either local or remote voltage control via resistance. The circuit consists of Q15 and associated components and reference voltage source provided by VR1 and temperature compensation diode CR10. R69 provides 1 milliampere calibration.

(11) Current Reference Circuit. The current reference circuit is identical to the voltage reference circuit described above. It consists of Q16 and associated components and is routed to TB1-8 (IPROG.) for local or remote current control via resistance. R71 provides 1 milliampere calibration.

(12) Voltage Control. Voltage control and error amplification are provided by U8 and associated components. The (+) non-inverting sensing input is routed from the (+) sensing terminal of TB1 through resistor divider R99, R100, R101. The (-) inverting control input is routed (local or remote operation)

from TB2-4 (VCONT) through impedance matching resistor R97. The network R98 and C60 provides voltage loop compensation. Error amplifier U8 amplifies any error signal and provides a control signal to the pulse-width modulator through CR15, when operating in the voltage mode. C58 provides voltage loop compensation. R106 is an offset adjustment for zero nulling. R101 is for full-scale calibration (see Chapter 5 for calibration and adjustment procedures).

(13) Current Control. Current control and error amplification are provided by U7 and associated components. Current control (local or remote) is routed from TB2-9 through resistor R91 to the (-) inverting input of error amplifier U7. R92 and C56 provide current loop compensation. The (+) non-inverting input is routed from the current shunt R18 through divider resistors R88 and R90 and impedance matching resistor R89. Error amplifier U7 compares the inputs, amplifies any error signal and provides a control signal to the pulse-width modulator through CR11, when operating in the current mode. R86, C53 and C54 provide additional current loop compensation. R87 is an offset adjustment for zero nulling. R88 is for current full-scale calibration (see Chapter 5 for calibration and adjustment procedures).

(14) Current Monitor/Parallel Tracking Amplifier. The current monitor/parallel tracking amplifier consists of U6D and associated components. The primary purpose of this amplifier is to provide an output of 0 to 1 mA to TB1-12 (IMON+) corresponding to 0 to 100% of rated output current, when used in a parallel configuration. When not used for parallel operation, TB1-12 provides a 0 to 5 VDC monitor signal corresponding to 0 to 100% of rated output current. Both amplifier inputs are provided by current shunt R18. Gain is controlled by resistors R76, R77 and R78 which are calibrated to provide 0 to 5 VDC for 0 to 100% current output at U6D, pin 14. This 0 to 5 VDC is routed through R74 to provide 0 to 1 mA, when used in the parallel configuration. The output is also routed through R73 to provide current meter drive.

(15) Voltage/Current Mode Indicators. The indicators, LED 1 (voltage) and LED 2 (current) on the display assembly A2 are driven by U6-A and U6-B, respectively, through R83 and R82. U6-A output and U6-B inverted input are tied together, providing one output high at all times.

When the power supply is operating in the voltage control mode, the output from U8 is more positive than from U7. The output is coupled through CR14 to U6A, pin 3, (+) input, thus causing U6-A, pin 1, output to be high. This output drives the voltage mode indicator through R83.

When the power supply is operating in the current control mode, U7 (current control) will be more positive than U8 (voltage control). The output is coupled through CR12 to the (-) input

of U6-A, pin 2. This drives the output of U6A, pin 1, low and thus U6B, pin 7, high for the current mode indicator drive through R82.

(16) Remote Interface. The remote interface is simply the barrier strip TB1 and appropriate jumpers to permit user selection of local/remote voltage sensing. The barrier strip is mounted directly on the converter board and is accessible at the rear panel. See Chapter 3 of this manual for local/remote control and sensing connections.

c. Display Assembly A2 (Reference schematic 10-010-086-90). The primary purpose of the display assembly is to provide voltage and current meter displays at the front panel. Bias power for the display assembly is provided by the control assembly A1. The ±12 volt inputs are regulated by U1(+) and U2(-) to provide ±5 volt power to the A/D converters U3 and U4.

The A/D converters with associated components provide all necessary functions to convert analog input signals to digital driver outputs for the 3-1/2" displays LCD1 and LCD2. Analog inputs are provided by the control assembly A1.

The A/D converters U3 and U4 zero automatically. Full-scale calibration is provided by R8 for the ammeter and R11 for the voltmeter. Fixed decimal point location for the LCD displays is factory set via a solder bridge connection.

Other functions provided on the front panel for convenient access or viewing include: the overvoltage adjustment potentiometer R1, the overvoltage indicator LED1, the current mode indicator LED2 and the voltage mode indicator LED3.

CHAPTER 5

MAINTENANCE AND CALIBRATION

5-1. INTRODUCTION

This chapter contains preventive and corrective maintenance information for the Series 3300. To isolate defective components, use standard troubleshooting procedures in conjunction with the principles of operation in Chapter 4, the list of materials information in Chapter 6 and the drawings in Chapter 7.

5-2. EQUIPMENT REQUIRED

Table 5-1 lists the test equipment required to perform maintenance on the Series 3300. The recommended model or an equivalent may be used.

5-3. PREVENTIVE MAINTENANCE

Preventive maintenance for the Series 3300 consists of scheduled inspection and cleaning.

a. Schedule. Table 5-2 lists the preventive maintenance routines and the recommended performance intervals.

b. Inspection. Table 5-3 lists the visual inspection checks to be performed. It also indicates the corrective action to be taken.

c. Cleaning. Cleaning requirements are based on the need established during inspection. If cleaning is required, follow the instruction listed in the corrective action column of Table 5-3.

5-4. REPAIR

Repair of the Series 3300 is performed by removing and replacing failed parts and components. Information required to order replacements is contained in Chapter 6, List of Materials.

Table 5-1. Test Equipment Required

COMMON NAME	REQUIRED CAPABILITIES	RECOMMENDED MODEL
Digital Multimeters	AC and DC Ranges	Hewlett-Packard Model 3468A
Oscilloscope	Signal and Waveform Measurement	Tektronix 2215
Resistive Load	For Full-Rated Output Voltage and Current of P.S. Model Type.	
Current Shunt	For Full-Rated Output Current	EMPRO Type HA or Equipment

Table 5-2. Preventive Maintenance Schedule

PREVENTIVE MAINTENANCE ROUTINE	RECOMMENDED PERFORMANCE INTERVAL
Inspection	Annual
Cleaning	As Required

Table 5-3. Inspection and Corrective Action

ITEM	INSPECT FOR	CORRECTIVE ACTION
Connector plugs and jacks	Looseness, bent or corroded contacts, damage or improper seating in mating connector	Clean contacts with solvent moistened cloth, soft bristle brush, small vacuum or low compressed air. Replace connectors damaged, deeply corroded, or improperly seated in mating connector.
Chassis, blower & extruded heatsinks	Dirt and Corrosion	Clean with cloth moistened with soapy water.
Electrical wiring	Broken, burned or pinched wire; frayed, worn or missing insulation	Repair or replace defective wires.
Soldering connections	Corrosion, loose, cracked, or dirty connections	Clean and resolder connections.
Dirt and moisture buildup	Short circuits, arcing, corrosion, overheating	Clean as required.
Front panel controls and meters	Dirt and corrosion	Clean with cloth moistened with soapy water. Use a Kimwipe tissue and GTC glass cleaning compound to clean the meter faces.

5-5. CALIBRATION AND ADJUSTMENTS

To perform the following calibration and adjustment procedures, the cover must be removed from the power supply. Because removal of the cover allows access to potentially hazardous power voltages (up to 253 VAC and 358 VDC) and because of the importance of accurate readings to performance, only technically trained personnel should perform calibration procedures.

WARNING

Hazardous voltages (up to 253 VAC and 358 VDC) are present during equipment operations. Press switch to OFF position and disconnect power cord from power source. Allow a minimum three minutes for discharge of storage capacitance before removing the cover or performing any maintenance function. Wear safety glasses with cover removed.

a. Converter Assembly Calibration. Reference assembly 10-010-085-90 while performing calibration procedures.

(1) Voltage Reference. The voltage reference is provided by an adjustable current regulator Q15. To calibrate for the 1 mA programming coefficient (constant voltage) the following sequence is recommended.

(a) Remove all jumpers and external connections to TB1-3.

(b) Set current control potentiometer on front panel fully counterclockwise.

(c) Connect a precision digital multimeter (DMM) to TB1-3(+) with reference to TB1-7(-). Set DMM to DC milliamps and 2 milliamp range.

(d) Apply power to power supply.

(e) Adjust R69 for 1.000 milliamps on DMM.

(f) Remove power from power supply.

(g) Reconnect all jumpers/connections to TB1-3 as required for local or remote voltage control.

(2) Current Reference. The current reference is a precision current source consisting of Q16 and associated resistors. Calibration is accomplished through adjustment of R71. The following sequence is recommended.

(a) Remove all jumpers and external connections to TB1-8.

(b) Set voltage control potentiometer on front panel fully counterclockwise.

(c) Connect a precision DMM to TB1-8(+) with reference to TB1-11(-). Set DMM to DC milliamps and 2 milliamp range.

(d) Apply power to power supply.

(e) Adjust R71 for 1.000 milliamps on DMM.

(f) Remove power from power supply.

(g) Remove DMM and reconnect jumpers/connections for TB1-8 as required for local or remote current control.

(3) Voltage Zero Calibration. The voltage control circuit (U8) zero is adjusted by R106. The following sequence is recommended.

(a) Connect jumper (short circuit) between TB1-4 and TB1-6.

(b) Connect resistive load and DMM across output terminals of power supply. Set Dmm to read DC volts and approximately 200 millivolt range.

(c) Set current control potentiometer full clockwise.

(d) Apply power to power supply.

(e) Adjust R106 until the power supply output voltage starts to increase in the normal polarity. Reverse adjustment direction of R106 until output voltage decreases to zero reading on the DMM. Do not continue adjustment once the output reads zero millivolts.

(f) Remove power from power supply.

(g) Remove resistive load and DMM from power supply output terminals.

(h) Remove jumper from TB1-4 and TB1-6.

(4) Voltage Full-Scale Calibration. Full-scale voltage calibration is adjusted with R101. The following sequence is recommended.

(a) Connect a resistive load across output terminals.

(b) Connect a DMM between TB1-2 and TB1-6. Set DMM to DC volts and the scale to read maximum rated power supply voltage.

(c) Connect a second DMM between TB1-4(+) and TB1-6(-). Set DMM to DC volts and scale to read 5.00 volts.

(d) Rotate current control to maximum clockwise.

(e) Apply power to power supply.

(f) Rotate voltage control for 5.00 volt reading to DMM attached to TB1-4 and TB1-6.

(g) Adjust R101 until output voltage reading is 100% of rated output voltage DC between TB1-2 and TB1-6.

(h) Remove power from power supply.

(i) Remove DMM's and resistive load from power supply terminals.

(5) Current Zero Calibration. The current control circuit (U7) zero is adjusted with R87. The following sequence is recommended.

(a) Connect a jumper (short circuit) between TB1-9 and TB1-11.

(b) Connect a resistive load and DMM across the output terminals of the power supply. Set DMM to read DC volts and approximately 200 millivolt range.

(c) Set voltage control potentiometer on front panel fully clockwise.

(d) Apply power to power supply.

(e) Adjust R87 until the power supply output voltage starts to increase in the normal polarity. Reverse adjustment direction of R87 until output voltage decreases to zero reading on the DMM. Do not continue adjustment when the output reads zero volts.

(f) Remove power from power supply.

(g) Remove resistive load and DMM from power supply output terminals.

(h) Remove jumper between TB1-9 and TB1-11.

(6) Current Full-Scale Calibration. Full-scale current calibration is adjusted with R88. The following sequence recommended.

(a) Connect an external calibrated current shunt between the power supply negative output and a

resistive load bank capable of full-rated power. (Optionally, the shunt may be connected between the power supply positive and negative output bus bars.)

(b) Connect DMM across current shunt sensing terminals.

(c) Connect a DMM between TB1-9(+) and TB1-11(-). Set to 200 millivolt range.

(d) Set front panel voltage control potentiometer fully clockwise.

(e) Apply power to power supply.

(f) Adjust front panel current control for 100 millivolt reading on DMM across TB1-9 and TB1-11.

(g) Adjust R88 until rated output current flows through external current shunt.

(h) Remove power from power supply.

(i) Reconfigure power supply for normal operation.

(7) Current Monitor/Parallel Tracking Amplifier Zero Calibration. The current monitor/parallel tracking amplifier zero is adjusted with R79. The following sequence is recommended.

(a) Connect a jumper (short circuit) between RB1-9 and TB1-11.

(b) Connect a resistive load across output terminals.

(c) Connect a DMM between TB1-12(+) and TB1-13(-). Set DMM to DC volts on 0.2 volt scale.

(d) Set front panel voltage and current control potentiometers fully counterclockwise.

(e) Apply power to power supply.

(f) Adjust R79 to 0.00 volts on DMM.

(g) Remove power from power supply.

(h) Remove jumper between TB1-9 and TB1-11.

(i) Remove resistive load from power supply output terminals.

(8) Current Monitor/Parallel Tracking Amplifier full-Scale Calibration. The current monitor/parallel tracking amplifier is adjusted with R77. The following sequence is recommended.

(a) Connect an external calibrated current shunt between the power supply negative output and a resistive load bank capable of full-rated power. (Optionally, the shunt may be connected between the power supply positive and negative output bus bars.)

(b) Connect a DMM across the current shunt sensing.

(c) Connect a DMM between TB1-12 and TB1-13.

(d) Set front panel voltage control potentiometers fully clockwise.

(e) Apply power to power supply.

(f) Set front panel current control potentiometers for rated output current through external current shunt.

(g) Adjusted R77 for 5.00 volts DC reading on DMM connected between TB1-12 and TB1-13.

(h) Remove power from power supply.

(i) Reconfigure power supply for normal operation.

b. Display Assembly. Reference schematic drawing 10-010-086-90 while performing calibration.

(1) Meter Zero Calibration. The zero set for both voltage and current front panel meter is automatic.

(2) Meter Full-Scale Calibration. The full-scale adjustment for the digital panel meters M1 and M2 is adjusted by R8 and R11, respectively, of the display assembly 10-010-086-00. R8 is for full-scale current meter calibration and R11 is for full-scale voltage meter calibration. Both resistors are accessible from inside the power supply when the cover is removed.

To calibrate for full-scale voltage or current, adjust the power supply to maximum rated output voltage (or current) using external calibrated meters and adjust the appropriate meter to correspond to the rated output voltage or current.

CHAPTER 6

LIST OF MATERIALS

6-1. INTRODUCTION

The repair parts list contains the major parts required to maintain the Series 3300. To ensure accurate procurement of replacement parts, the information contained in the parts list columns must be used effectively. The following paragraph describes the parts list format and includes an explanation of the information presented in each of the columns.

The ITEM column contains the part number Power Ten has assigned to items both purchased and Power Ten manufactured. The SEQ column contains the bill of materials sequence number in ascending order. The DESCRIPTION column contains the standard identifying noun or item name. The QTY column contains the quantity for a unique configuration which is identified by a dash number. The REFERENCE column contains reference designations of the electrical components.

BILL OF MATERIALS
POWER TEN INC.
FOR ASSEMBLY 3300D-2030

ITEM	SEQ	DESCRIPTION	QTY	REFERENCE
12-070-086-00	1	CHASSIS BASE, REV E (3300	1.0	
12-070-087-00	2	CHASSIS, COVER, REV A (33	1.0	
12-330-039-00	3	PANEL, FRONT, REV B (3300	1.0	
12-180-004-00	4	HANDLE,3/16"RND, 1" X 1"	2.0	
10-010-085-04	5	ASSY, CONVERTER, REV I, 2	1.0	A1
10-010-086-00	6	ASSY, DISPLAY,, REV A, 1-	1.0	A2
12-100-003-00	7	BEZEL,DISPLAY	2.0	
12-180-007-00	8	KNOB,BLK 1/4	2.0	
05-050-008-00	9	SWITCH,TOG,DPST,15A	1.0	S1
11-180-010-00	10	EMI FILTER	1.0	FL-1
09-030-026-00	11	BARRIER STRIP, 2 POS	1.0	TB-1
11-070-038-00	12	CIRCUIT BREAKER, 10A	1.0	CB-1
08-010-016-00	13	FAN,BISCUIT 115V	1.0	BL-1
10-020-043-00	14	ASSY, HARNESS, REV A (330	1.0	
09-100-030-00	15	BARRIER STRIP,COVER 2 POS	1.0	
03-500-038-00	19	RES. POT., 5K,2W,5%	1.0	R1
03-500-007-00	20	RES.POT 100ohm 2W 5%	1.0	R2
15-100-632-04	21	SCREW,PPH,6-32 X 1/4"SS	2.0	
15-100-632-06	22	SCREW,PPH,6-32 X 3/8"SS	5.0	
15-100-632-08	23	SCREW,PPH,6-32 X 1/2"SS	2.0	
15-460-003-00	24	WASHER,FIBER SHLDR #6	2.0	
15-400-600-01	25	WASHER,FLAT #6,SS STD	11.0	
15-420-600-00	26	WASHER,SPLIT #6,SS	11.0	
15-110-440-05	27	SCREW,PFH,4-40 X 5/16"SS	16.0	
15-100-440-08	28	SCREW,PPH,4-40 X 1/2"SS	4.0	
15-100-440-04	29	SCREW,PPH,4-40 X 1/4"SS	5.0	
15-400-400-00	30	WASHER,FLAT #4,SS	9.0	
15-420-400-00	31	WASHER,LOCK #4,SS	9.0	
15-300-632-00	32	NUT,HEX 6-32,SS	4.0	
15-500-632-10	33	STANDOFF,HEX 6-32 X .625,	4.0	-
09-090-003-00	37	JUMPER, OVER BARRIER	7.0	-
12-270-006-00	40	CARTON,3300 SERIES	1.0	-
12-150-019-00	43	NYLON CLAMP .312"DIA	1.0	-

BILL OF MATERIALS
POWER TEN INC.
FOR ASSEMBLY 10-010-085-04

ITEM	SEQ	DESCRIPTION	QTY	REFERENCE
10-010-085-XX	1	ASSY, CONVERTER, REV AB	1.0	-
01-215-210-20	4	CAP.CER .0015UF,1000V	4.0	C10,11,13,72
01-068-825-00	6	CAP.ELEC 6800UF,25V	2.0	C14,16
03-830-104-00	9	RES. M.O., 300,2W,5%	1.0	R17
11-130-022-02	10	SHUNT, CURRENT 10A,100mV	3.0	R18A,B,C
03-103-331-00	13	RES. C.F., 33K,1/4W,5%	1.0	R53
03-216-521-00	14	RES. M.F., 16.5K,1/4W,1%	1.0	R73
03-254-921-00	17	RES. M.F., 54.9K,1/4W,1%	1.0	R100
03-104-731-00	18	RES. C.F., 47K,1/4W,5%	1.0	R95
06-030-200-05	19	XFMR, 20V,63A, REV -	1.0	T4
06-050-080-08	20	INDUCTOR,170uH,30A,REV B	1.0	L1
07-080-039-00	21	DIODE,RECT. F.R. CT 100A,	1.0	CR1
06-050-045-00	22	INDUCTOR, RF CHOKE, REV A	2.0	L2,L2
11-160-024-00	23	BUS BAR, REV A	2.0	-
12-050-034-00	24	BRKT, XFMR MTG, REV A	4.0	XL1,T4
01-210-310-20	25	CAP.CER .01UF,1KV	1.0	C12
09-040-000-19	26	LUGS, TERM. SOLDER #1/4	4.0	
09-040-000-22	27	LUGS, TERM. RING TONGUE 1	22.0	
09-040-000-44	28	LUGS, TERM. CRIMP TERM	1.0	
09-040-000-69	30	SOLDER LUG, 5/15"	2.0	

BILL OF MATERIALS
POWER TEN INC.
FOR ASSEMBLY 10-010-085-XX

ITEM	SEQ	DESCRIPTION	QTY	REFERENCE
10-010-085-10	2	PWB, CONVERTER, REV K	1.0	
07-040-033-00	5	RECT.BRIDGE MB3510	1.0	BR1
07-040-022-00	6	BRIDGE,RECT. 1A,100V	1.0	BR2
01-047-720-10	7	CAP.ELEC 470UF,200V	6.0	C1-6
01-547-440-10	8	CAP.FILM .47UF,400V,5%	1.0	C7
01-210-230-20	9	CAP.CER. HV .001UF,3KV	1.0	C8
01-210-310-20	10	CAP.CER .01UF,1KV	3.0	C18,19,76
01-210-410-20	11	CAP.CER .1UF,1KV	3.0	C15,17,77
01-047-735-01	12	CAP.ALUM 470UF,35V,20%	2.0	C20,21
01-047-635-00	13	CAP.ELEC 47UF,35V	3.0	C22,23,41
01-210-450-00	14	CAP.CER .1UF,50V	6.0	C24,25,30,37,43,44
01-210-450-00	15	CAP.CER .1UF,50V	5.0	C47,52,57,62,74
01-210-450-00	16	CAP.CER .1UF,50V	4.0	C65,66,69,75
01-210-120-10	17	CAP.CER 100PF,200V	5.0	C26,27,46,58,71
01-210-220-10	18	CAP.CER .001UF,200V,10%	6.0	C28,34,53,54,68,70
01-210-310-10	19	CAP.CER .01UF,100V,10%	7.0	C31,32,35,36,38,39,4
01-210-310-10	20	CAP.CER .01UF,100V,10%	8.0	C42,48-51,55,61,63
01-210-310-10	21	CAP.CER .01UF,100V,10%	2.0	C45,73
01-110-616-00	22	CAP.TANT. 10UF,16V	1.0	C33
01-233-350-00	23	CAP.CER .033UF,50V,10%	1.0	C56
01-233-450-00	24	CAP.CER .33UF,50V	1.0	C60
01-520-540-10	25	CAP.FILM 2UF,400V	1.0	C64
03-102-031-00	26	RES. C.F., 20K,1/4W,5%	2.0	R111,112
07-080-002-00	28	DIODE,SIG. 100MA,75V	6.0	CR3,4,5,6,7,8
07-080-002-00	29	DIODE,SIG. 100MA,75V	7.0	CR11-17
07-030-000-03	30	DIODE,RECT. 1A,400V	1.0	CR9
09-040-000-49	31	CONN. MALE SPADE, .250 PC	5.0	J1-J5
09-010-002-00	32	CONN. MALE 24 PIN, .1CTRS	1.0	J6
09-010-019-00	33	CONN. MALE 2 PIN HEADER	1.0	J7
09-020-029-00	34	CONN. FEMALE 2 POS JUMPER	1.0	P7
07-010-000-46	36	XSTR.FET. 15A,400V	4.0	Q1-4
07-020-000-02	37	XSTR.NPN. 500MA,40V	5.0	Q5,8,10,11,14
07-020-000-01	38	XSTR.PNP. 500MA,40V	7.0	Q6,7,9,12,15,16,18
07-050-000-04	39	PHOTO COUPLER	1.0	Q17
03-104-311-00	40	RES. C.F., 430,1/4W,5%	1.0	R59
03-602-595-00	41	SURGE LIMITER, 2.5 OHM,15	2.0	R1,2
03-302-036-00	42	RES. W.W., 20K,11W,5%	1.0	R3
03-105-111-00	43	RES. C.F., 510,1/4W,5%	7.0	R4,5,11,12,19,20,27
03-105-111-00	44	RES. C.F., 510,1/4W,5%	2.0	R28,31
03-301-017-03	45	RES. W.W.,100,20W,NI	2.0	R6,7
03-810-004-00	46	RES. M.O., 10,2W,5%	1.0	R13
03-103-011-00	47	RES. C.F., 300,1/4W,5%	5.0	R21,22,25,26,109
03-101-011-00	48	RES. C.F., 100,1/4W,5%	1.0	R49
03-105-121-00	49	RES. C.F., 5.1K,1/4W,5%	1.0	R30
03-240-211-00	50	RES. M.F., 4.02K,1/4W,1%	1.0	R32
03-210-001-00	51	RES. M.F., 100,1/4W,1%	1.0	R33
03-101-021-00	52	RES. C.F., 1K,1/4W,5%	6.0	R34,35,44,55,60,66
03-101-021-00	53	RES. C.F., 1K,1/4W,5%	7.0	R80-83,92,23,24
03-101-041-00	54	RES. C.F., 100K,1/4W,5%	5.0	R36,45,63,75,110

BILL OF MATERIALS
POWER TEN INC.
FOR ASSEMBLY 10-010-085-XX

ITEM	SEQ	DESCRIPTION	QTY	REFERENCE
03-105-631-00	55	RES. C.F., 56K,1/4W,5%	1.0	R37
03-101-031-00	56	RES. C.F., 10K,1/4W,5%	7.0	R38,40,43,46,52,54,5
03-101-031-00	57	RES. C.F., 10K,1/4W,5%	5.0	R58,62,84,85,89
03-101-031-00	58	RES. C.F., 10K,1/4W,5%	4.0	R94,96,97,98
03-104-731-00	59	RES. C.F., 47K,1/4W,5%	1.0	R39
03-214-011-00	60	RES. M.F., 1.4K,1/4W,1%	2.0	R41,42
03-102-021-00	61	RES. C.F., 2.0K,1/4W,5%	2.0	R47,56
03-101-231-00	62	RES. C.F., 12K,1/4W,5%	1.0	R48
03-102-041-00	63	RES. C.F., 200K,1/4W,5%	2.0	R50,51
03-303-985-00	64	RES. W.W., .39,5W,5%	1.0	R61
03-101-022-00	65	RES. C.F., 1K,1/2W,5%	1.0	R64
03-102-001-00	66	RES. C.F., 20,1/4W,5%	1.0	R67
03-500-030-00	67	RES. TRIMPOT, 2K,1/2W	3.0	R69,71,107
03-106-811-00	68	RES. C.F., 680,1/4W,5%	1.0	R72
03-224-921-00	69	RES. M.F., 24.9K,1/4W,1%	1.0	R76
03-500-003-01	70	RES. TRIMPOT, 10K,1/2W	2.0	R88,101
03-101-051-00	71	RES. C.F., 1M,1/4W,5%	1.0	R78
03-500-021-00	72	RES. TRIMPOT, 100K,1/2W	3.0	R79,87,106
03-210-031-00	73	RES. M.F., 100K,1/4W,1%	2.0	R90,102
03-220-021-00	74	RES. M.F., 20K,1/4W,1%	1.0	R99
03-102-791-01	75	RES. C.F.,2.7,1/4W,5% W/	2.0	R103,104
03-851-204-00	76	RES. M.O., 5.1K,2W,5%	1.0	R65
03-232-411-00	77	RES. M.F., 3.24K,1/4W,1%	1.0	R105
03-210-021-00	78	RES. M.F., 10K,1/4W,1%	1.0	R91
03-500-041-00	79	RES. TRIMPOT, 50K,1/2W	1.0	R77
07-110-000-01	80	SCR 25A,100V	1.0	SCR1
06-030-000-97	81	XFMR. GATE DRIVE, REV A	2.0	T1,2
06-030-000-75	82	XFMR, REV -, BIAS (3300)	1.0	T3
09-030-023-00	83	BARRIER STRIP, 16 POS	1.0	TB1
07-070-000-05	84	I.C. REG. 1.5A,12V	1.0	U1
07-070-000-25	85	I.C. REG. .1A,-12V	1.0	U2
07-130-000-06	86	I.C.THERMAL SENSOR LM335Z	1.0	U3
07-070-000-38	87	I.C. PWM, 3525A	1.0	U4
07-050-000-23	88	I.C. J-FET INPUT OP. AMP	1.0	U8
07-050-000-31	89	I.C. J-FET INPUT OP. AMP	1.0	U7
07-050-000-01	90	I.C., OP. AMP QUAD	2.0	U6,9
07-070-000-15	91	I.C. REG.	1.0	U5
11-030-000-08	92	WIRE, BUS,#22 TINNED COPP	2.0	W9,10
07-060-000-14	93	DIODE,ZEN. 6.2V	1.0	VR2
11-030-000-09	94	WIRE, BUS #18, TINNED COP	1.0	W1-W3,6-7
12-070-090-00	96	HEATSINK, REV -	1.0	XBR1
12-070-088-00	97	HEATSINK, REV E	1.0	
12-070-089-00	98	HEATSINK, REV -	1.0	
07-100-000-20	100	SOCKET, 16 PIN I.C.	1.0	XU4
07-100-000-19	101	SOCKET, 14 PIN DIP	2.0	XU6,9
15-520-007-00	103	SPACER,NYLON .25LG X .25D	8.0	XQ1-Q4
15-170-632-12	104	SCREW,PPH,6-32 X 3/4"BR	8.0	XQ1-Q4
15-440-006-00	105	WASHER,FLAT #6,BR	16.0	XQ1-Q4
15-470-006-00	106	WASHER,LOCK #6,BR	8.0	XQ1-Q4

BILL OF MATERIALS
POWER TEN INC.
FOR ASSEMBLY 10-010-085-XX

ITEM	SEQ	DESCRIPTION	QTY	REFERENCE
15-290-632-00	107	NUT,HEX 6-32,BR	8.0	XQ1-Q4
15-120-440-10	108	SCREW,SH CAP,4-40 X 5/8"S	6.0	
15-400-400-00	109	WASHER,FLAT #4,SS	12.0	
15-420-400-00	110	WASHER,LOCK #4,SS	6.0	
15-300-440-00	111	NUT,HEX 4-40,SS	6.0	
15-100-632-08	112	SCREW,PPH,6-32 X 1/2"SS	8.0	XT4,L1
15-100-632-06	113	SCREW,PPH,6-32 X 3/8"SS	3.0	XU1,T3
15-100-632-12	114	SCREW,PPH,6-32 X 3/4"SS	1.0	XBR1
15-400-600-01	115	WASHER,FLAT #6,SS STD	21.0	
15-420-600-00	116	WASHER,SPLIT #6,SS	12.0	
15-300-632-01	117	NUT,HEX 6-32 REDUCED OD .	12.0	
07-100-000-03	118	INSUL. WASHER,MICA, TO-3	4.0	XQ1-Q4
15-400-600-00	119	WASHER,FLAT #6,SS ROD	3.0	XT3,U1
12-010-000-11	120	EPOXY, THERMAL CONDUCTIVE	0.0	XU3
15-100-632-48	121	SCREW,PPH,6-32 X 3"SS	4.0	
07-070-000-40	122	I.C., VOLT REG,5V,REF.	1.0	VR1
03-240-211-00	123	RES. M.F., 4.02K,1/4W,1%	2.0	R68,70
03-249-911-00	124	RES. M.F., 4.99K,1/4W,1%	1.0	R74
03-105-131-00	125	RES. C.F., 51K,1/4W,5%	1.0	R86
07-060-000-01	126	DIODE,ZEN. 5.1V,1/2W,+/-1	1.0	VR3
03-102-731-00	127	RES. C.F., 27K,1/4W,5%	1.0	R95

BILL OF MATERIALS
POWER TEN INC.
FOR ASSEMBLY 10-010-086-00

ITEM	SEQ	DESCRIPTION	QTY	REFERENCE
10-010-086-10	1	PWB, DISPLAY, REV C	1.0	
01-210-310-20	3	CAP.CER .01UF,1KV	1.0	C17
01-147-550-00	4	CAP.TANT 4.7UF,50V	2.0	C5,11
01-047-635-00	5	CAP.ELEC 47UF,35V	2.0	C1,2
01-210-450-01	6	CAP.CER .1UF,50V	4.0	C3,4,10,12
01-222-450-01	7	CAP.CER .22UF,50V	2.0	C9,13
01-247-450-01	8	CAP.CER .47UF,50V	2.0	C8,14
01-210-310-10	9	CAP.CER .01UF,100V,10%	2.0	C7,15
01-210-120-10	10	CAP.CER 100PF,200V	2.0	C6,16
03-500-040-00	11	RES. TRIMPOT, 100K,.27DIA	1.0	R1
03-224-921-00	12	RES. M.F., 24.9K,1/4W,1%	2.0	R7,10
03-500-035-00	13	RES.TRIMPOT,100,.3W	2.0	R8,11
03-245-301-00	14	RES. M.F., 453,1/4W,1%	2.0	R9,12
03-104-731-00	15	RES. C.F., 47K,1/4W,5%	2.0	R6,13
03-101-051-00	16	RES. C.F., 1M,1/4W,5%	2.0	R4,17
03-101-041-00	17	RES. C.F., 100K,1/4W,5%	2.0	R5,14
03-210-001-00	18	RES. M.F., 100,1/4W,1%	2.0	R3,16
07-100-007-00	20	SOCKET, 40 PIN DIP	2.0	
07-070-000-33	21	I.C. REG. .1A,+5V	1.0	U1
07-070-000-34	22	I.C. REG. .1A,-5V	1.0	U2
07-050-000-28	23	I.C. A/D CONV/DRIVER	2.0	U3,4
11-050-023-00	25	DISPLAY,DIGIT LCD 3 1/2"	2.0	LCD1,2
09-010-014-00	26	CONN. MALE 16 PIN HEADER	1.0	J1
11-020-011-00	27	LED, RED DIFF, .2 DIA	3.0	LED1,2,3
15-520-007-00	28	SPACER,NYLON .25LG X .25D	3.0	-

BILL OF MATERIALS
POWER TEN INC.
FOR ASSEMBLY 10-020-043-00

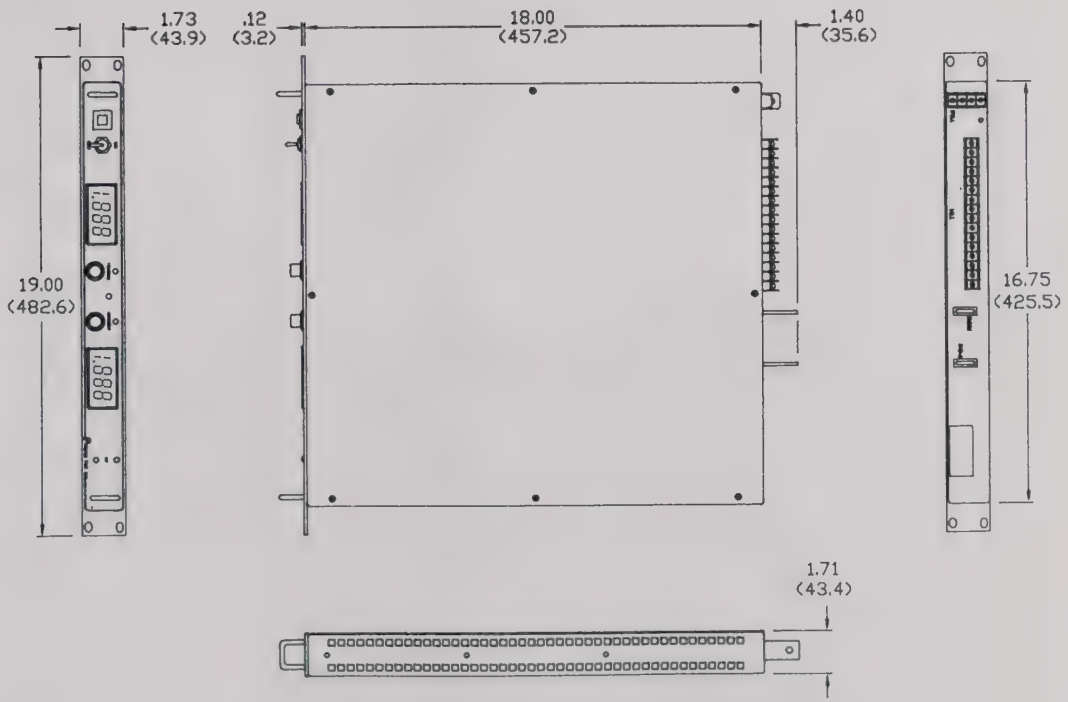
ITEM	SEQ	DESCRIPTION	QTY	REFERENCE
09-020-002-00	1	CONN. FEMALE 24 PIN, .1 C	1.0	J6
09-020-016-00	2	CONN. FEMALE 16 PIN	1.0	J1
12-150-001-00	3	TYWRAPS	25.0	
09-040-000-40	4	LUG, TERM. 16/14 AWG	17.0	
09-040-000-45	5	LUGS, TERM. CRIMP TERM	5.0	
09-100-002-00	6	CONN. COVER 24 PIN, .1 CT	1.0	
09-100-014-00	7	CONN. COVER 16 PIN	1.0	
09-040-000-50	8	DISCONNECT,NYLON .110X.03	2.0	-
12-150-010-00	9	CABLE TIE MOUNTING DEVICE	2.0	
12-150-002-00	10	TYWRAPS	4.0	
11-030-000-16	11	WIRE, VIOLET,22GA	2.1	J6-1/J1-10
11-030-000-11	12	WIRE 22AWG YELLOW HOOKUP	2.1	J6-2/J1-12
11-030-000-26	13	WIRE, YEL/BLK,22GA	2.1	J6-3/J1-11
11-030-000-03	15	WIRE, WH/RED,22GA	2.1	J6-5/J1-5
11-030-000-05	16	WIRE, WH/YEL,22GA	2.1	J6-6/J1-16
11-030-000-19	17	WIRE 22AWG WH/BLU HOOKUP	2.1	J6-7/J1-1
11-030-000-25	18	WIRE 22AWG RED/BLU HOOKUP	2.1	J6-8/J1-14
11-030-000-06	20	WIRE, WH/GRN,22GA	2.1	J6-10/J1-7
11-030-000-27	21	WIRE, YEL/GRY,22GA	2.1	J6-11/J1-3
11-030-000-13	22	WIRE, GREY,22GA	2.3	J6-12/R1-2
11-030-000-02	23	WIRE, WH/BRN,22GA	2.3	J6-13/R2-2
11-030-000-01	26	WIRE, 22AWG BLACK HOOKUP	2.1	J6-16/J1-6
11-030-000-22	27	WIRE 22AWG YEL/BLU HOOKUP	2.1	J6-17/J1-13
11-030-000-01	29	WIRE, 22AWG BLACK HOOKUP	2.1	J6-19/J1-2
11-030-000-01	30	WIRE, 22AWG BLACK HOOKUP	2.1	J6-20/J1-15
11-030-000-14	31	WIRE, BRN,22GA	2.3	J6-21/R2-1
11-030-000-10	32	WIRE, BLUE,22GA	2.3	J6-22/R1-1
11-030-000-24	33	WIRE, RED/WH,22GA	2.1	J6-23/J1-4

CHAPTER 7

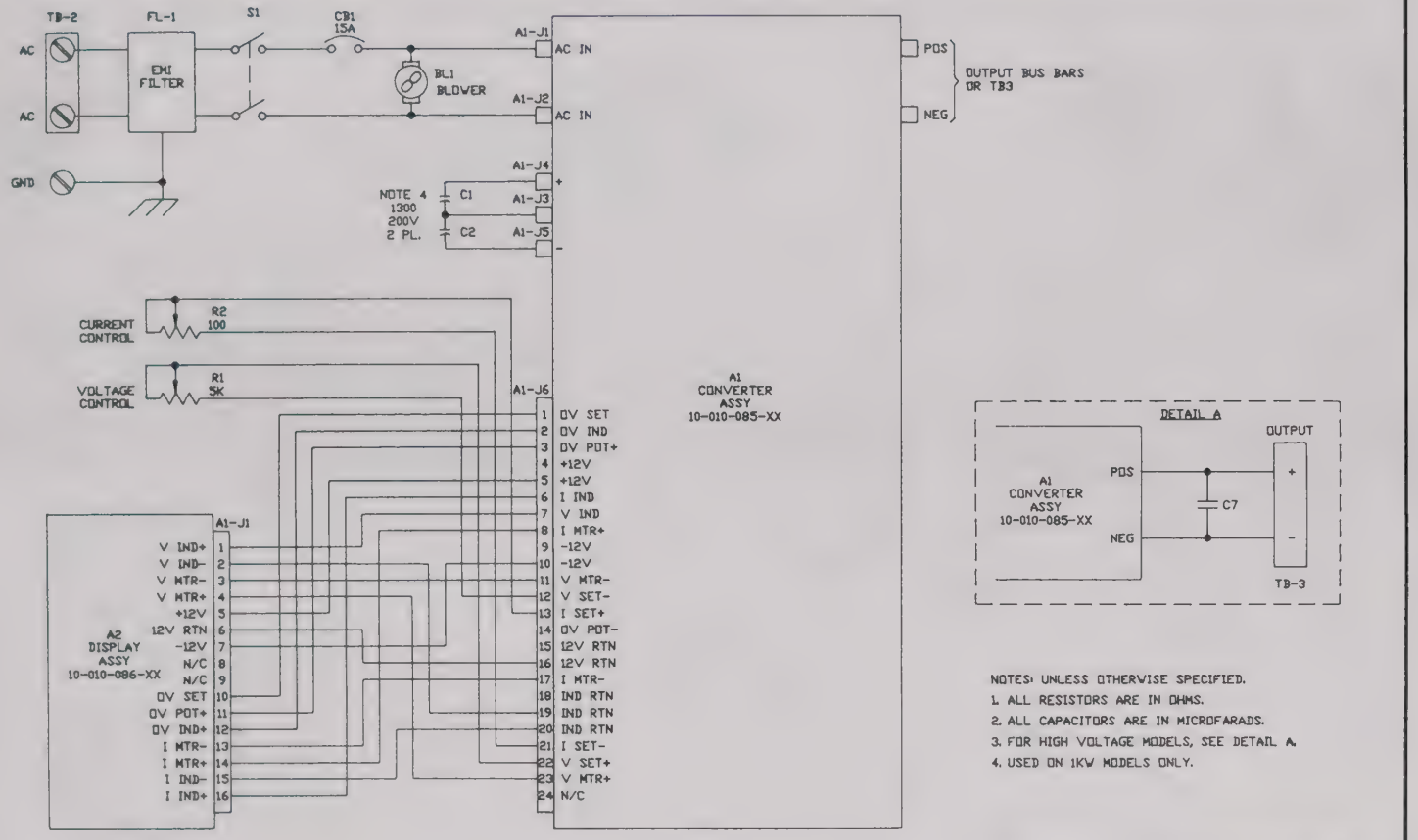
DRAWINGS

7-1. INTRODUCTION

This chapter contains the appropriate schematic drawings for the Series 3300 Power Supply.



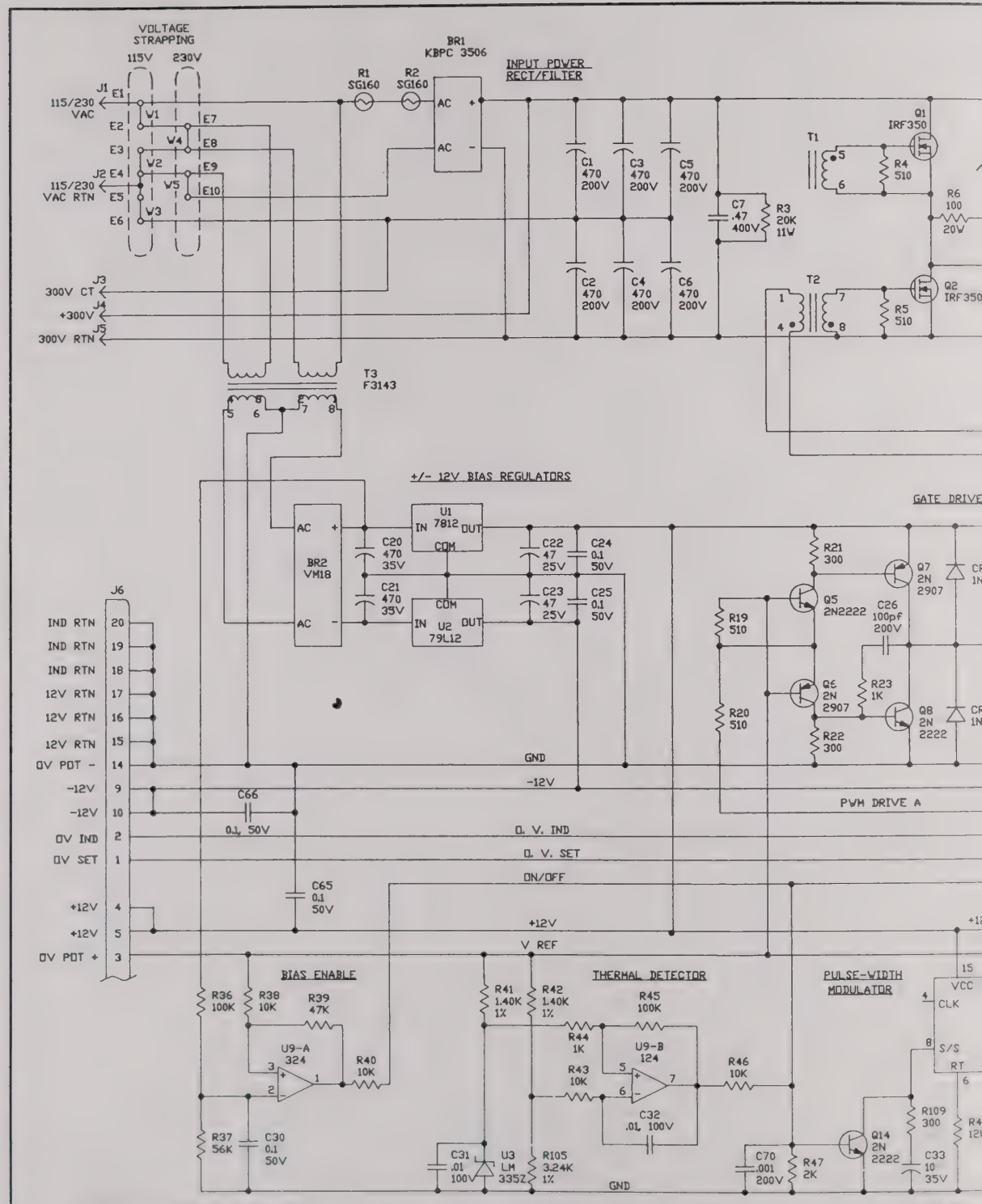
3300 Series Outline Drawing



NOTES: UNLESS OTHERWISE SPECIFIED.

1. ALL RESISTORS ARE IN OHMS.
2. ALL CAPACITORS ARE IN MICROFARADS.
3. FOR HIGH VOLTAGE MODELS, SEE DETAIL A.
4. USED ON 1KW MODELS ONLY.

APPROVALS	DATE	POWER TEN INC. SUNNYVALE CA, 94086
DRAWN JFB	7/26/93	SCHEMATIC, TOP ASSEMBLY 3300 P.S.
CHECKED		SIZE C · FSCM NO. 61987 · DWG NO. 3300-90 · REV B
ISSUED		SCALE · CODE 3300TASC · SHEET 1 OF 1

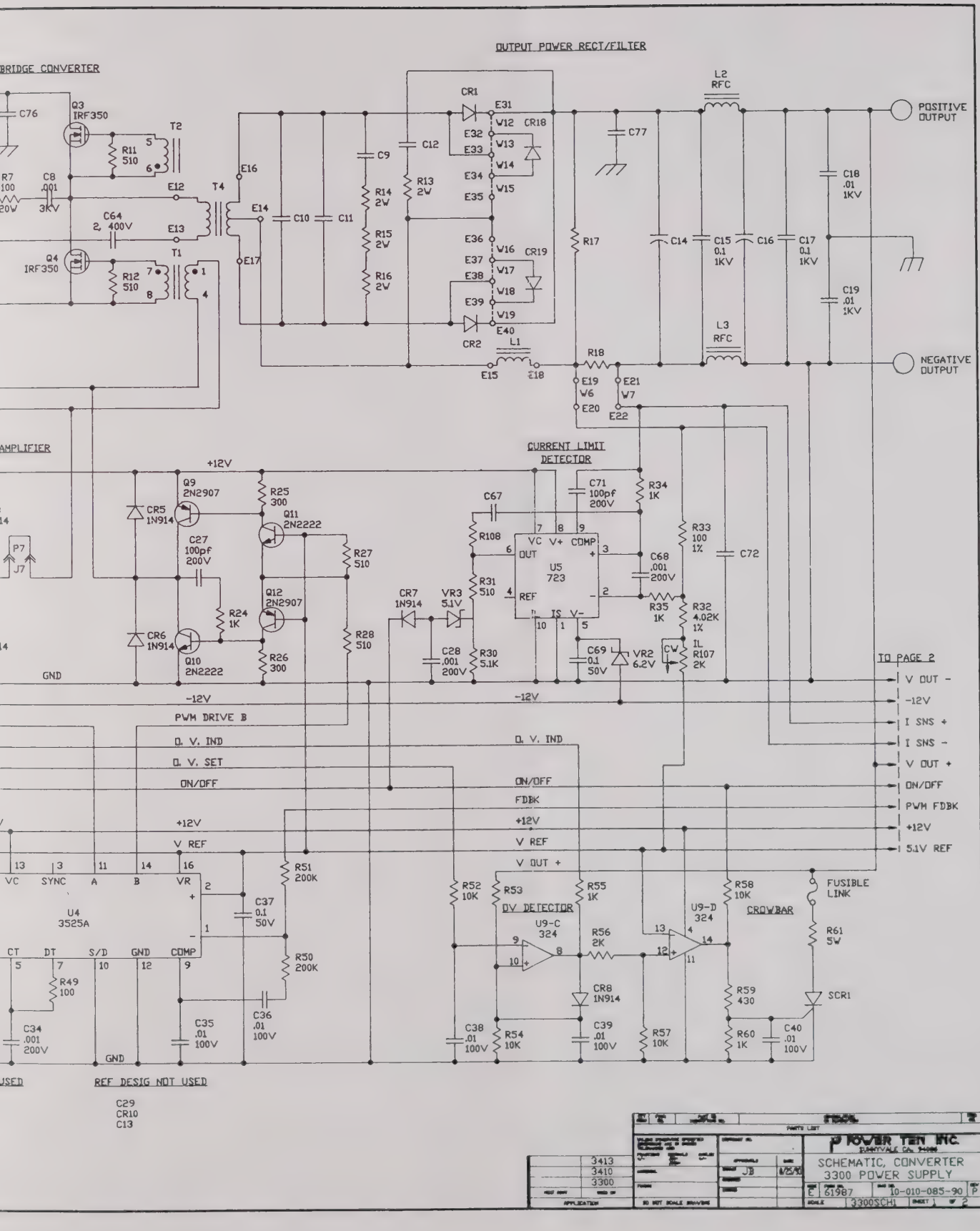


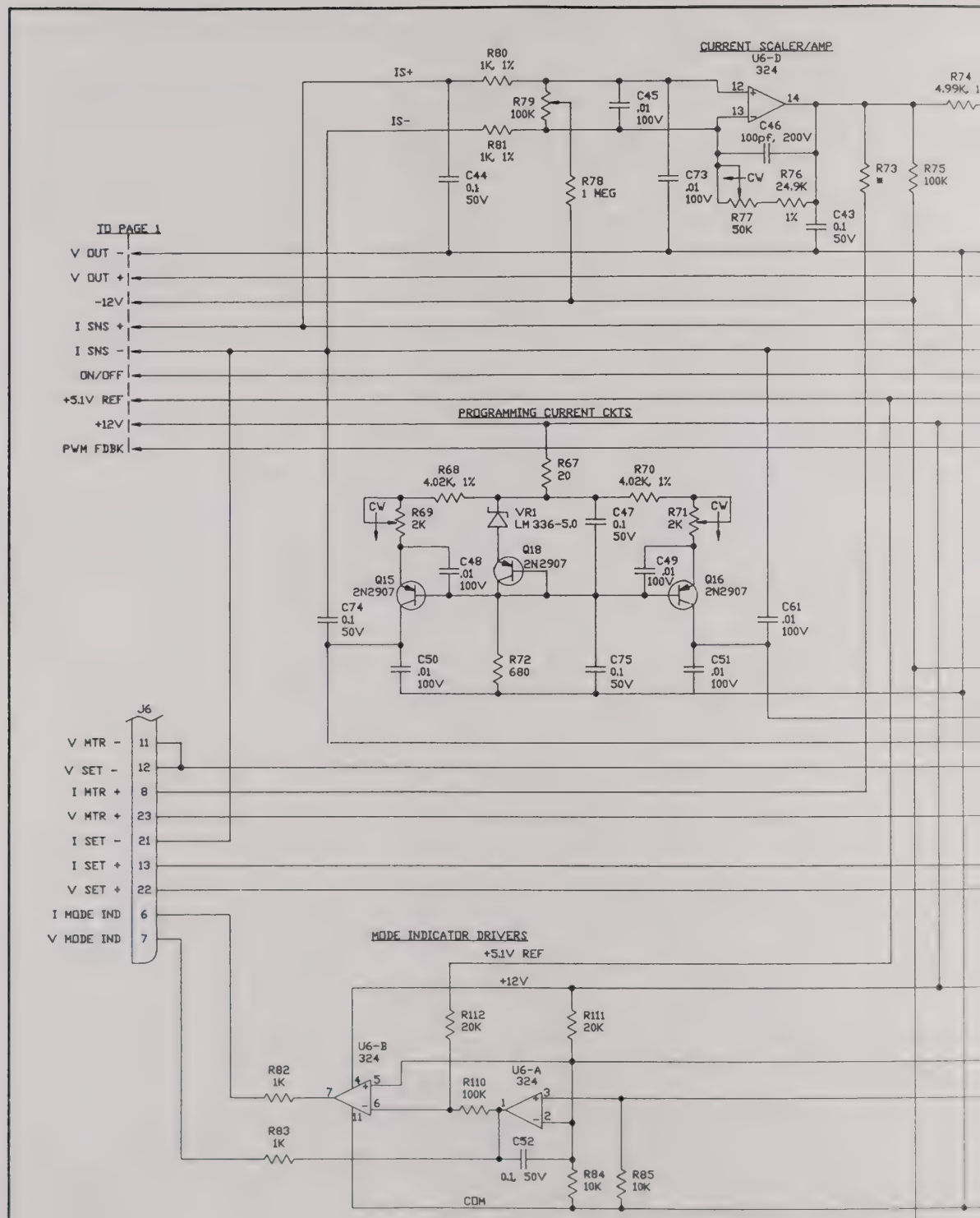
NOTES: UNLESS OTHERWISE SPECIFIED

1. INTERPRET THIS DRAWING PER DOD-STD-100.
2. ALL RESISTORS ARE 1/4 WATT, 5%. RESISTANCE VALUES ARE IN OHMS.
3. CAPACITANCE VALUES ARE IN MICROFARADS.
4. SEE PARTS LIST FOR NON-SPECIFIED VALUES.
5. FOR UNITS <80VDC OUTPUT, INSTALL JUMPERS W12, W14, W17, & W19.
   FOR UNITS >100VDC OUTPUT, INSTALL JUMPERS W13, W15, W16, & W18.

LAST REF DESIG

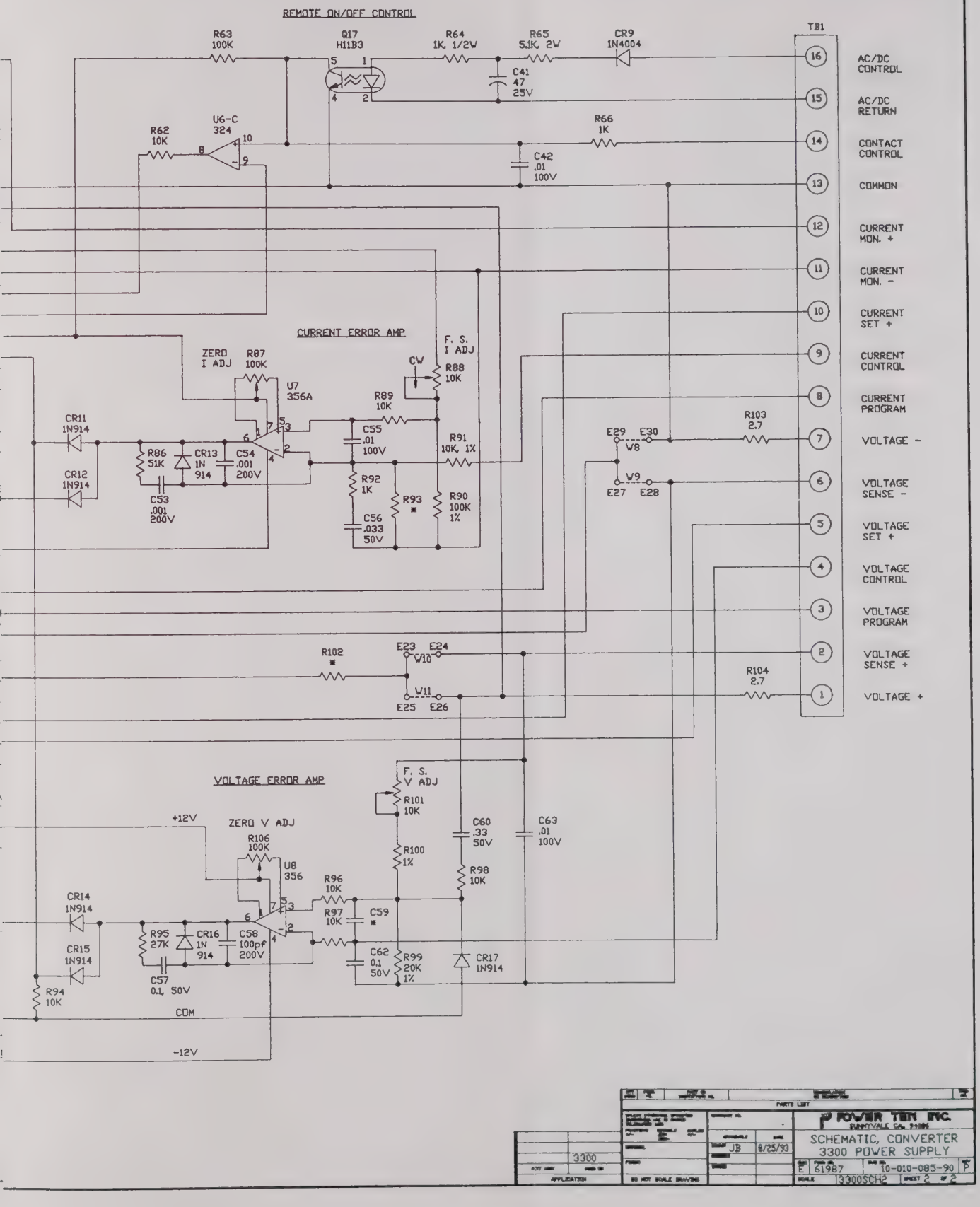
BR2	T4
C77	U9
CR19	VR3
J7	W19
L3	E40
Q18	TB1
R112	
SCR1	

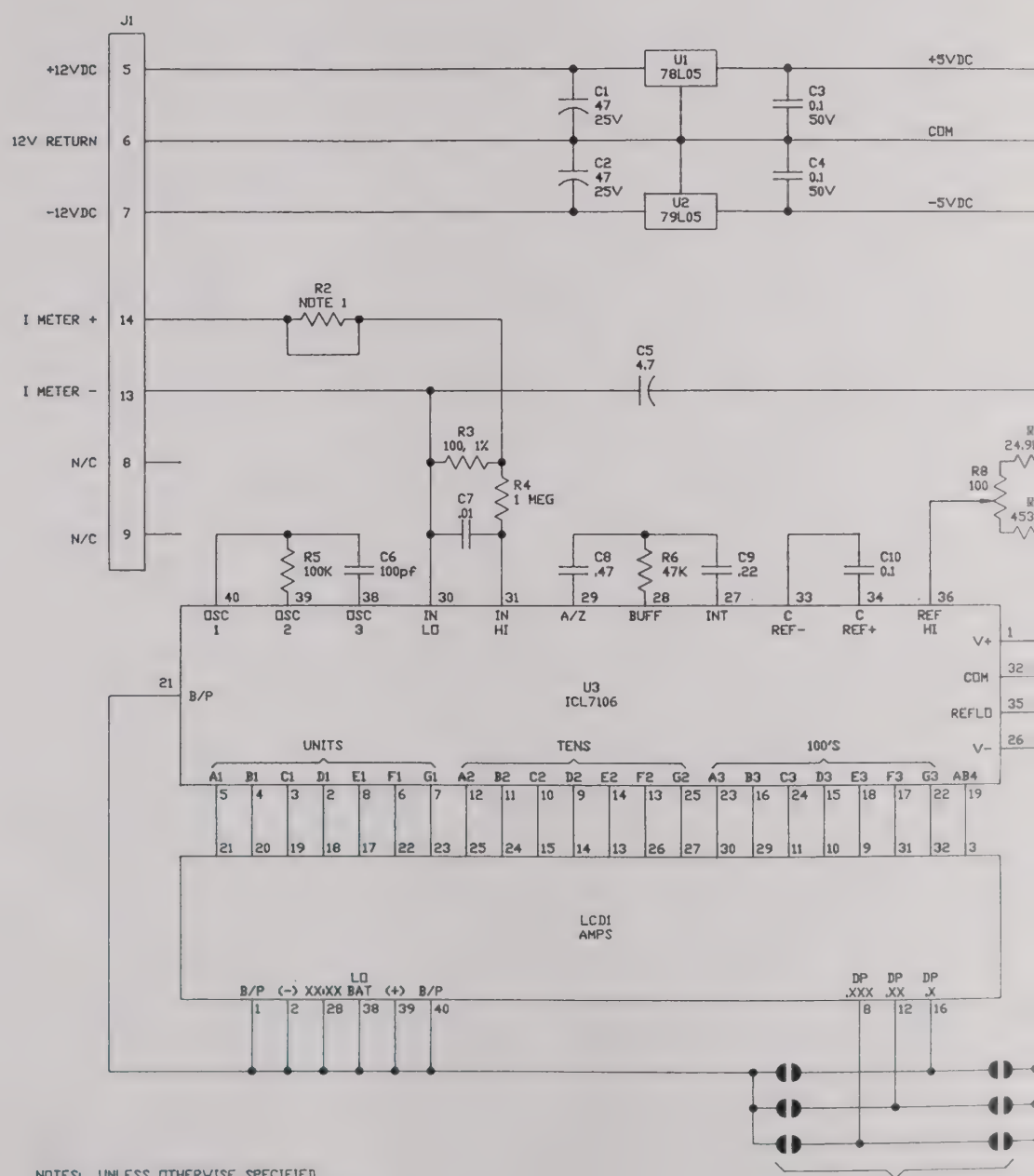

OUTPUT POWER RECT/FILTER
BRIDGE CONVERTER
AMPLIFIER
Q3 IRF350
Q4 IRF350
T1
T2
T4
C76
C8 .001 3KV
C64 2, 400V
R11 510
R12 510
R7 100 20W
CR1
CR2
CR18
CR19
L1
L2 RFC
L3 RFC
C9
C10
C11
C12
C13
C14
C15 0.1 1KV
C16
C17 0.1 1KV
C18 .01 1KV
C19 .01 1KV
C77
R13 2W
R14 2W
R15 2W
R16 2W
R17
R18
POSITIVE OUTPUT
NEGATIVE OUTPUT
E15
E16
E17
E18
E19
E20
E21
E22
E31
E32
E33
E34
E35
E36
E37
E38
E39
E40
W6
W7
W12
W13
W14
W15
W16
W17
W18
W19
+12V
GND
-12V
CURRENT LIMIT DETECTOR
Q9 2N2907
Q10 2N2222
Q11 2N2222
Q12 2N2907
CR5 1N914
CR6 1N914
CR7 1N914
R24 1K
R25 300
R26 300
R27 510
R28 510
C27 100pf 200V
C28 .001 200V
R30 5.1K
VR3 5.1V
U5 723
VC V+ COMP OUT REF IS V-
R31 510
R108
C67
C68 .001 200V
C69 0.1 50V
C71 100pf 200V
R32 4.02K 1%
R33 100 1%
R34 1K
R35 1K
C72
VR2 6.2V
CV
IL
R107 2K
P7
J7
TO PAGE 2
V OUT -
I SNS +
I SNS -
V OUT +
ON/OFF
PWM FDBK
5.1V REF
PWM DRIVE B
O. V. IND
O. V. SET
ON/OFF
FDBK
V REF
V OUT +
U4 3525A
VC SYNC A B VR
CT DT S/D GND COMP
R49 100
C34 .001 200V
C35 .01 100V
C36 .01 100V
C37 0.1 50V
R50 200K
R51 200K
DV DETECTOR
U9-C 324
U9-D 324
R52 10K
R53
R54 10K
R55 1K
R56 2K
R57 10K
R58 10K
R59 430
R60 1K
C38 .01 100V
C39 .01 100V
C40 .01 100V
CR8 1N914
SCR1
CROWBAR
FUSIBLE LINK
R61 5W
USED
REF DESIG NOT USED
C29
CR10
C13
POWER TEN INC.
SCHEMATIC, CONVERTER
3300 POWER SUPPLY
3413
3410
3300
61987
10-010-085-90
3300SCH1



NOTES: UNLESS OTHERWISE SPECIFIED

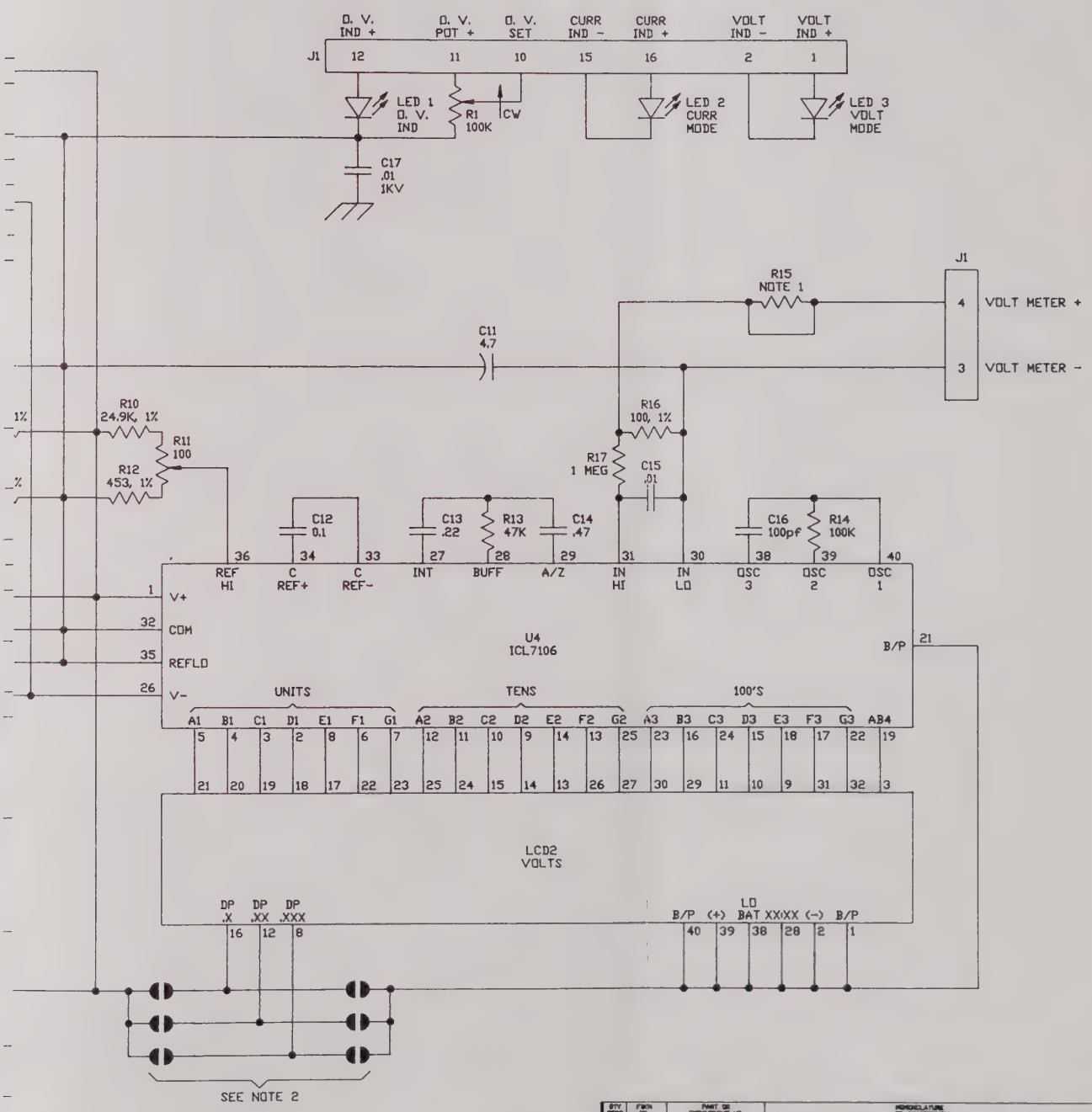
1. INTERPRET THIS DRAWING PER DOD-STD-100
2. ALL RESISTORS ARE 1/4 WATT, 5%. RESISTANCE VALUES ARE IN OHMS.
3. CAPACITANCE VALUES ARE IN MICROFARADS.
4. ITEMS MARKED WITH AN ASTERISK (*) VARY IN VALUE. SEE PARTS LIST FOR VALUE.


REMOTE ON/OFF CONTROL
R63 100K
Q17 H11B3
R64 1K, 1/2W
R65 5.1K, 2W
CR9 1N4004
C41 47 25V
R62 10K
U6-C 324
R66 1K
C42 .01 100V
TB1
16 AC/DC CONTROL
15 AC/DC RETURN
14 CONTACT CONTROL
13 COMMON
12 CURRENT MON. +
11 CURRENT MON. -
10 CURRENT SET +
9 CURRENT CONTROL
8 CURRENT PROGRAM
7 VOLTAGE -
6 VOLTAGE SENSE -
5 VOLTAGE SET +
4 VOLTAGE CONTROL
3 VOLTAGE PROGRAM
2 VOLTAGE SENSE +
1 VOLTAGE +
CURRENT ERROR AMP
ZERO I ADJ
R87 100K
U7 356A
F. S. I ADJ
CW
R88 10K
R89 10K
CR11 1N914
CR12 1N914
R86 51K
CR13 1N 914
C54 .001 200V
C53 .001 200V
C55 .01 100V
R91 10K, 1%
R92 1K
R93
R90 100K 1%
C56 .033 50V
E29 E30 W8
E27 E28 W9
R103 2.7
R104 2.7
R102
E23 E24 W10
W11 E25 E26
VOLTAGE ERROR AMP
F. S. V ADJ
R101 10K
+12V
ZERO V ADJ
R106 100K
U8 356
R100 1%
C60 .33 50V
C63 .01 100V
R98 10K
R96 10K
R97 10K
C59
CR14 1N914
CR15 1N914
R95 27K
CR16 1N 914
C58 100pf 200V
C57 0.1, 50V
C62 0.1 50V
R99 20K 1%
CR17 1N914
R94 10K
COM
-12V
POWER TEN INC.
SCHEMATIC, CONVERTER
3300 POWER SUPPLY
3300
JB 8/25/93
61987
10-010-085-90
3300SCH2



NOTES: UNLESS OTHERWISE SPECIFIED

1. CUT TRACE WHEN RESISTOR IS INSTALLED.
2. ALL DECIMAL POINT INPUTS MUST BE TERMINATED EITHER TO V+ (ACTIVE) OR TO BACKPLANE (NON-USED).



PARTS LIST			
QTY REQD	FSCM NO.	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION

	4600
	4500
MATERIAL	3300
FINISH	N/A
NEXT ASSY	USED ON
APPLICATION	DO NOT SCALE DRAWING

CONTRACT NO.		
APPROVALS		DATE
DRAWN	JB	8/89
CHECKED		
ISSUED		

POWER TEN INC.
SUNNYVALE CA. 94086

SCHEMATIC DIAGRAM
DISPLAY ASSEMBLY

SIZE	FSCM NO.	DWG NO.	REV
D	61987	10-010-086-90	C

SCALE N/A | CODE 3300DSSC | SHEET 1 OF 1

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58806
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MP MASTER
MA36024
88891